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THE CHEMICAL AGE

VOL LVII 27 DECEMBER 1947 No 1485

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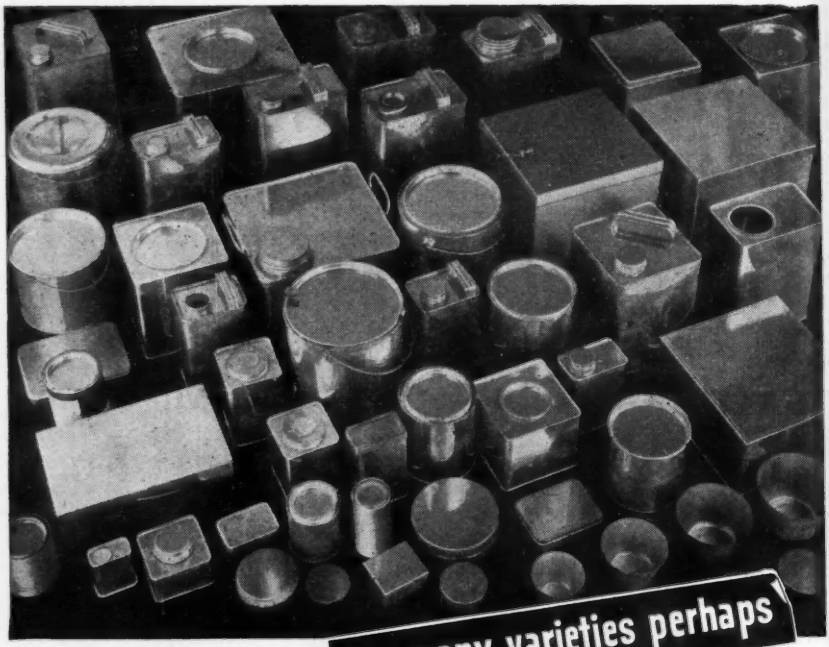

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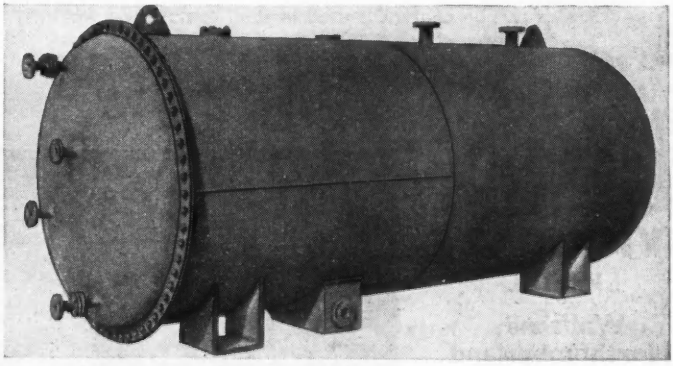

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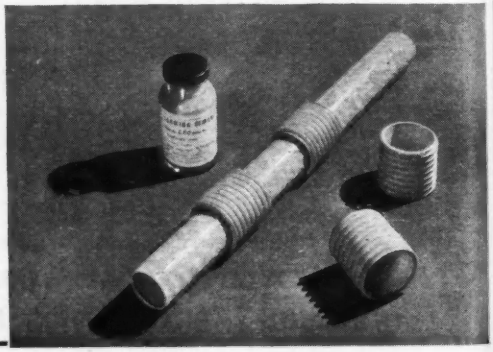

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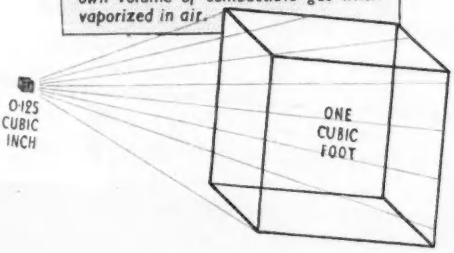

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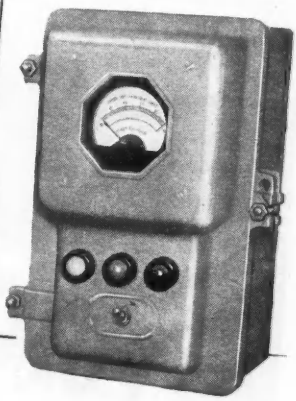
The POOLE Automatic Combustible Gas Alarm can, if necessary, be set to operate when the concentration by volume of inflammable liquid in air reaches as little as four parts in one million.



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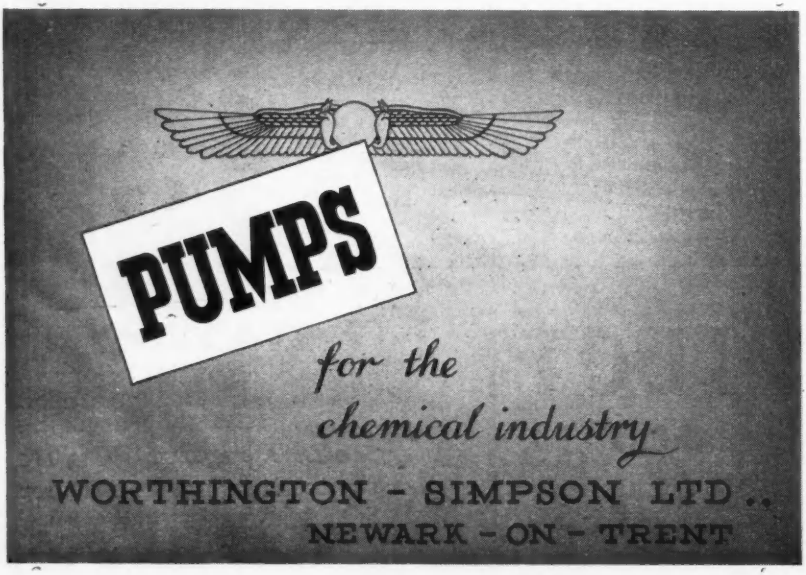

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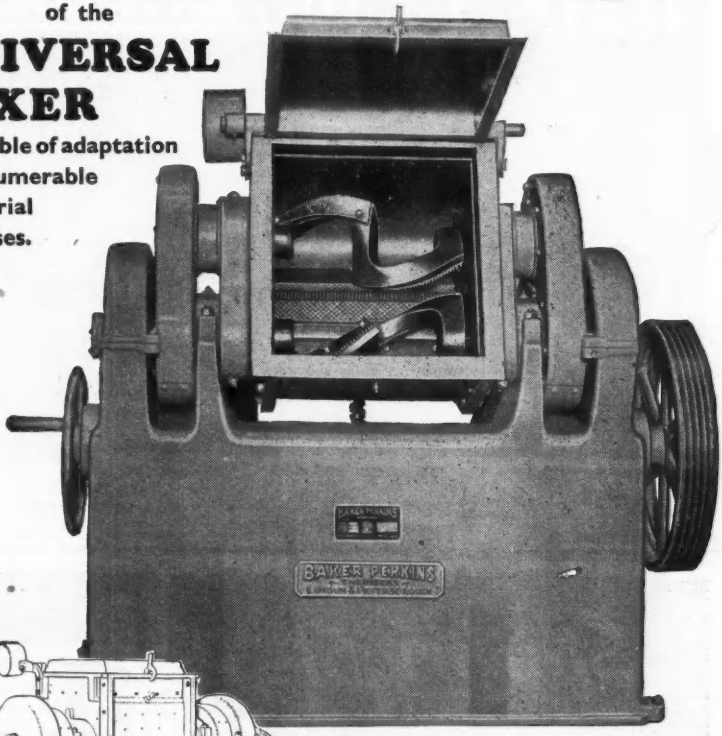

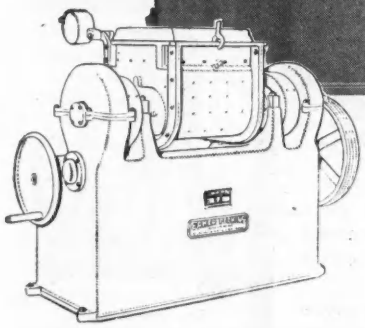

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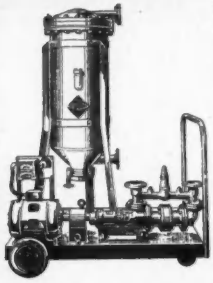

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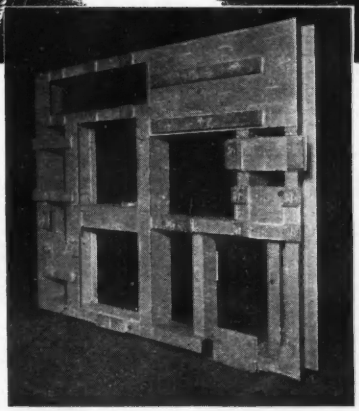

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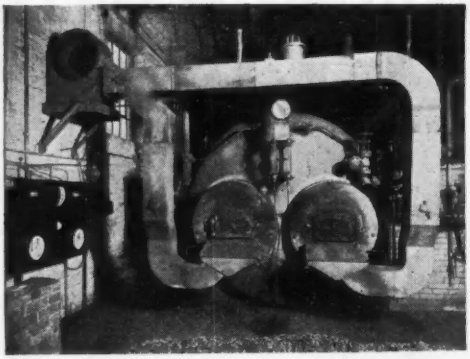

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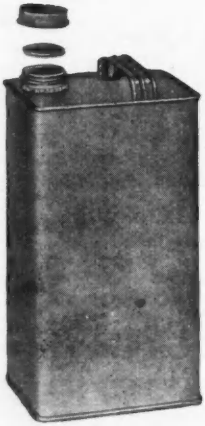

Square can showing patent screw neck.
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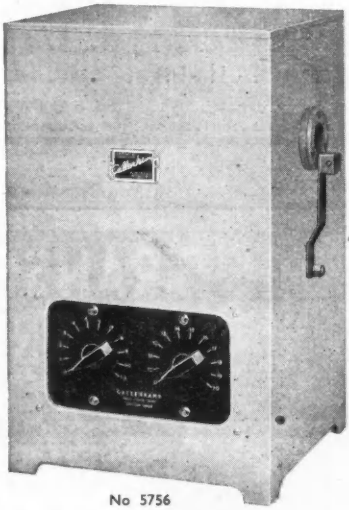

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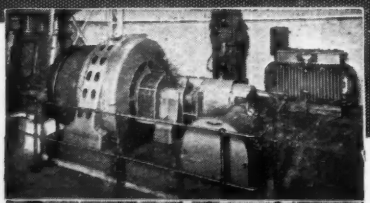

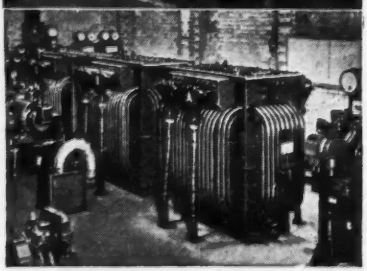

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The illustrations show :—
(Above) Hackbridge transformers supplying a compressor (By courtesy, Messrs. Rubery Owen Ltd.)
(Below) Hackbridge transformers installed in a works sub-station.

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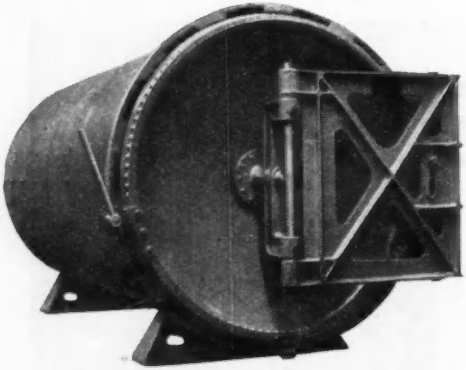

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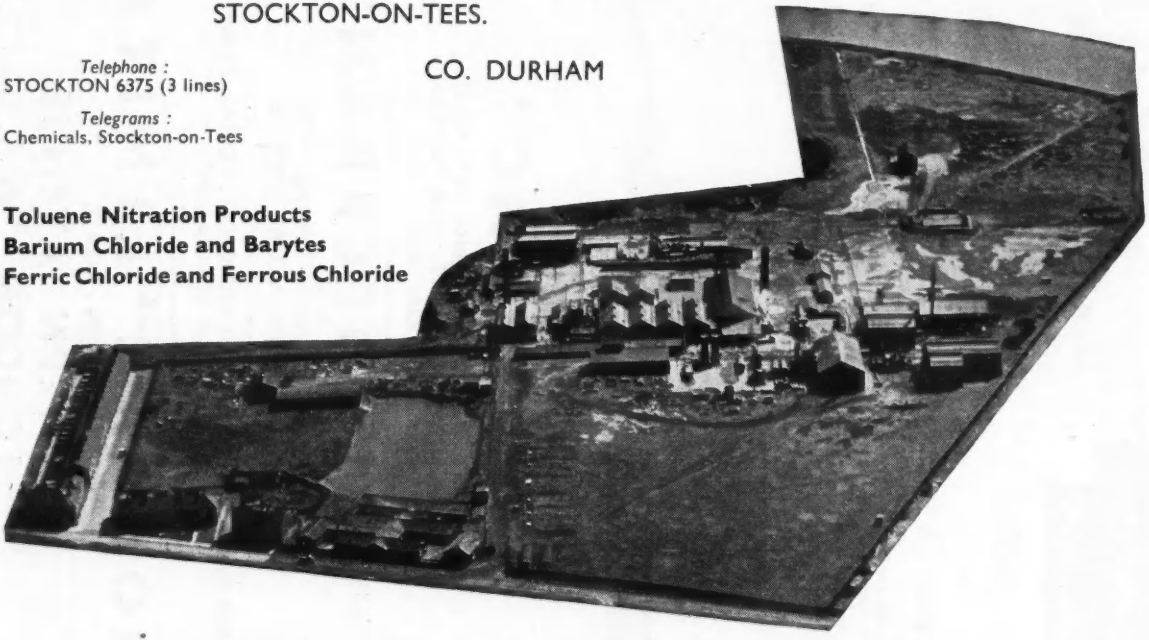

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VOL. LVII
No. 1485.

27 December 1947

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Looking Ahead

THE exhortations of Ministers of the Crown are renewed almost daily urging us to produce more for export. The necessity for doing so is acknowledged and, as pointed out in our leading article on December 6, there are even reasons for suggesting that it would be better to concentrate more on long-term export and less on fulfilling our present needs.

We have called attention in the past to the need for an organised policy in securing orders for plant and products abroad. We pointed out on many occasions before the war the necessity for personal contact between manufacturers in Britain and their customers abroad. We urged that there should be greater attention to the business of salesmanship abroad, and that not only should British-staffed agencies be established in overseas countries but that heads of British firms should meet their clients in their own countries.

The world has grown much smaller since those years and physically it is no more difficult now for a manufacturer to visit his customers several thousands of miles away than it was a hundred years ago for him to visit his customers in other parts of Great Britain. In post-war conditions travel restrictions and all manner of official formalities have to be circumvented, means of transport are congested and it is necessary to secure official priority in order to make the journeys: A prerequisite of putting into effect a virile commercial policy is therefore that the Government should give its assistance to business men to travel abroad in search of orders.

The acute necessity for giving thought to this problem of organisation of our foreign trade arises from the fact that we are undoubtedly reaching the time when our customers will no longer be prepared to take whatever we may give them. The sellers' market will have given place to the normal condition of a buyers' market. We have at best a few months' breathing space in which to make our plans. Many firms, having order books full for at least two years ahead, may not recognise the urgency of the problem. The crisis will come when our order books are no longer full. It is during these next months that we should be establishing good relations with those foreign buyers.

The problem has another facet no less important: has the Government organisation abroad been brought up to date since the war? It was understood that at the end of the war the Foreign Office would overhaul its machinery and would see that commercial attaches with real knowledge of British industry would be stationed in important trade centres all over the world. Consuls derived from the local populations, as they so frequently were in the past, tend to conduct our business in a perfunctory manner and seldom have either the enthusiasm or the knowledge required to seek orders for British firms. We have seen little tangible evidence of changes in Foreign Office methods and we should suggest that British trade associations should take up this matter very seriously with the Government if they are not already satisfied with what is being done.

Conditions after the last war were anything but satisfactory. Just how bad they were was recalled by Mr. W. Wakefield

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Adam, speaking to the Institute of Export, on his experiences abroad, experiences affording a classic example of how things should not be done.

"When I was resident in Madrid for some years in the early twenties," he said, "I witnessed a great setback to British business in Spain. The British Ambassador was a very nice kindly old gentleman to whom even the mention of anything connected with business would have been considered the height of vulgarity. The American Ambassador was a big business man who had made a vast fortune, and was serving his country for the love of doing so. His attitude was that of a friendly business man, desirous to strengthen the bonds of friendship between Spain and the U.S. and also improve business relations.

"In a period of three years, Britain's trade position of imports to Spain fell from first place to third place, the U.S.A. rose from third place to first place, while Germany remained in the second place. The American Ambassador obtained a reduction of the duty on motor cars, he also had the telephone system modernised all over Spain by facilitating the starting of the 'Campania Nacional de Telephonos.'

"The British Ambassador, who was probably indifferent to or unaware of this tragedy, was promoted to be Ambassador in Washington. The new British Ambassador in Madrid was another of the 'Old School' with a superiority complex, a monocle and an Oxford accent. As you may imagine, Spanish spoken with an Oxford accent is rather dreadful to listen to and does not favourably impress Spanish people. The duty on British steel was raised, due to a German manœuvre, so that a number of directors and representatives from Sheffield made a special journey to Madrid, at considerable expense, to interview the British Ambassador to gain his assistance. He merely adjusted his monocle and said to them, 'I am afraid this is a matter for the Board of Trade.' So they all returned home, disgusted, and it was quite a time before anything was done by the Board of Trade.

"To conduct business successfully in Russia, it is absolutely essential that the British negotiator should not only be an experienced business man, but have a very good knowledge of the Russian language, and have considerable experience in the mental reactions of Russian business men.

"It is quite unsatisfactory to conduct negotiations through interpreters as so much is lost. Unless you can establish a real heart-to-heart relationship and be prepared for a certain amount of bargaining before reaching final agreement results will not be satisfactory." We fully believe him and wonder only just how soon that desirable state of affairs is to be brought about.

New Antibiotics Plant.—Speaking at a Christmas luncheon last week, Sir Harry Jephcott, chairman of Glaxo Laboratories, Ltd., said that the new antibiotics factory at Ulverston, Lancs, at present under construction, would include two fermentation units, and the entire scheme involved the expenditure of about £700,000.

NOTES AND COMMENTS

Suspended . . .

THE proportions of the setback which all industrial development—in which chemical industry has been one of the leaders—is receiving from the decisions of the White Paper on capital expenditure are becoming more fully apparent. The evidence of this which is now coming to hand is rendered all the less palatable by the knowledge that it must be the precursor of much more of the same sort. Among the most recent reminders is the announcement circulated by Courtaulds, Ltd., about their projected factory at Norwich for Norfolk Film Base, Ltd. Courtaulds' statement, which seems to signalise the cessation, for the time being at least, of progressive policy in many directions, records: "The company has been informed by the Ministry of Supply that work on the above factory will have to be suspended in accordance with the terms of the White Paper on Capital Investment in 1948. (Cmd. 7268.) The Ministry of Supply and the Board of Trade have confirmed that they continue to attach great importance to this project in view of the contribution it will make to the national economy . . ." The news, taken in conjunction with the Chancellor of the Exchequer's hint that the provisions of the White Paper might be carried even further "if necessity supervened" is hard to reconcile with the quiet confidence with which he enjoins the country to face the New Year.

Saving Fuel

DESPITE the recent cheering news of improved coal output, greater efficiency is still vitally needed in fuel utilisation. A welcome step in that direction was the recent film-meeting of the Institution of Chemical Engineers at which the theme of fuel efficiency was "discussed" in a film, "Combustion and the Chain-Grate Stoker." With animated diagrams, graphs and actual shots, the elementary chemistry of combustion and the need for excess air in boiler plants were skilfully portrayed. Stage by stage were shown the influences of various proportions of excess air on the different sources of heat loss, such as unburnt carbon removed with the ash, radiation losses and losses in the flue gases. Great increases in efficiency are being effected by using this sort of stoker, now adapted even to small installations. Combined with mechanical draught systems—particularly balanced draught—further improvements can certainly be achieved. Even the lower grade fuel which seems to preponderate now is being burned with higher efficiency. A number of shots of the fire bed taken with infra-red sensitive film clearly showed the sources of low CO_2 in the flue gases, due to unevenness in the bed permitting air to leak through. When properly adjusted, a fire on the chain-grate stoker finishes just short of the ash collector. In response to variation in the steam demands, the rate of movement of the grate and the rate of supply of coal have to be adjusted. Good control is evidently the paramount need here. The film was prepared at the request of Messrs. Babcock & Wilcox for engineers, for advertising and educational purposes. A trifle elementary perhaps for the applied chemist or engineer who has done any study—however limited—of combustion, this pictorial presentation, technically very good, should be very useful for students and boiler operators.

Giants and Atomies

THE immensity of much of the equipment that is being harnessed to the isolation, disruption and conversion of the infinitely small—in the atom research laboratories—was reflected most impressively by some of the scenes in the atomic energy film taken in the Cavendish laboratory. Now the Columbia University is reported to have set a fresh lead in the construction of gargantuan equipment, completing what must be the largest magnet: 38 steel blocks, each weighing 60 tons, some of them 33 ft. long. Despite the irresistible suggestion of Æsop's frog, this continuous inflation is destined to provide permanent benefits possibly of inestimable value, principally but not exclusively in the field of biochemistry. The fragments of atomic nuclei which should proceed from the vast synchro-cyclotron for which the magnet is intended may include new isotopes which have never been available for study. "They will probably have interesting properties from both the physical and chemical point of view," forecasts Prof. John R. Dunning, the scientific director of the project.

Export Licence Changes

Additions and Deletions

A NUMBER of changes in the list of goods requiring export licences are made by the Board of Trade Export of Goods (Control) (Consolidation) Order, 1947 S. R. & O., 1947, No. 2683) which comes into operation on December 31.

The following are among items which have been released from export licensing control: gum benzoin, gum mastic, saponaceous shaving creams and shampoos packed ready for retail sale, hand and bench tools, electric boiling and heating plates, dinitro-ortho-cresol and preparations, penicillin salts, concentrates and preparations of penicillin.

The following have been added to the export licensing list, and licences will be necessary in future for their export to all destinations: beeswax, candelilla wax, carnauba wax, ouricuri wax, and mixtures consisting wholly or mainly of one or more of these waxes, unassembled stampings and laminations of electrical sheet steel for incorporation in electrical machinery and apparatus, balsam of boru, balsam of tolu, bile salts, bismuth compounds, black haw bark, cimicifuga, desoxycorticosteone acetate, diastase, glycine, gonado trophic hormones, hamamelis bark and leaves, krameria root, lobelia, menthol, natural and synthetic, oestradiol and its esters, aestrone and its esters, podophyllum peltatum, podophyllum resin, progesterone, resorcinol, rutin, senega root, slippery elm bark, succinic acid and its salts, succinic anhydride, testosterone and its esters, wild cherry bark, witch hazel (distilled).

(3) The item relating to phenazone has been amended to read " phenazone and its salts and preparations thereof."

Copies of the order (5d.) can be obtained from the sales offices of H.M. Stationery Office, or through newsagents.

"MUCH MORE PENICILLIN"

"WE are on the verge of producing improvements which should result in much more penicillin," said Mr. E. G. Gross, director and general manager of the Distillers' Company (Bio-Chemicals), Ltd., which has now taken over from the Ministry of Supply the largest existing penicillin factory at Speke, near Liverpool, which cost £1,250,000 to build and equip. Within a matter of months, said Mr. Gross, they hoped to have the pilot plant in full production. The whole of the initial output would be used for research by the Medical Research Council. By Government order, 70 per cent of penicillin output is now directed to home purposes. That sent for export has brought in £873,643 during the past ten months.

Coal/Oil Scheme Halted

Insufficient Oil

BECAUSE of the insufficiency of oil tankers and the fact that the United States consumption of oil has risen by nearly 70 per cent since 1938 the Government has decided to discontinue plans for conversion from coal to oil burning.

Mr. Alfred Robens, Parliamentary Secretary to the Minister of Fuel and Power, said at a Press conference in London last week that the programme begun in the spring of 1946 with the object of saving 3 million tons of coal by the substitution of 2 million tons of oil during the period from May, 1946, to April, 1947, had resulted in the use of oil at a rate of 1,114,000 tons a year. The schemes authorised up to last August would, when completed, require 6 million tons of oil a year. 1277 industrial conversions had been completed out of a total of 2523 authorised and were now burning oil at the rate of 2,200,000 tons a year. More than a quarter of this had been taken by the steel industry, and was expected to lead to a substantial improvement in steel output.

New schemes due to come into operation next year would involve a rise in consumption over the year to a point where we should be consuming a further 2 million tons a year.

All firms now in process of converting to fuel oil were, therefore, being asked to inform the regional representative of the Petroleum Board of the stage reached in ordering and obtaining equipment, so that a programme of priorities might be drawn up for bringing these schemes into operation in an orderly manner as more oil became available.

GRADUATES GO SOUTH

ACCORDING to Dr. D. S. Anderson, director of the Glasgow Royal Technical College, Scottish industry is handicapping itself by its failure to make much wider use of technical personnel trained to the necessary level. Speaking at the presentation of diplomas and associateships at the college last week, he added that there was no doubt that this was one reason why so few of our new industries had been developed in Scotland itself as distinct from those brought there from the south.

For every graduate employed in Scottish industry there were 40 employed in England. This meant, making due allowance for the difference in population, that English industry was employing proportionately about five times as many graduates as industry in Scotland. Although 143 students were receiving diplomas and associateships that day, a great many more were needed to supply the demand for trained men.

Fertiliser Plants for India

Large Orders Placed for U.K. Chemical Equipment

FACED with the problem of feeding a population of about 400 millions, and remembering the disastrous famine in Bengal in 1943, the Government of India has embarked on a programme for the construction of three fertiliser plants in an endeavour to make the country fully self-supporting by increasing the yields of food products.

Anglo-American Construction

The first of the plants is to be erected at Sindri, in the province of Bihar. Design and construction have been entrusted to the Chemical Corporation of New York, while all matters relating to the purchase of plant and provision of construction services are in the hands of the Power-Gas Corporation, Ltd., of Stockton-on-Tees.

It is intended that the factory, actual construction of which has not yet commenced, shall go into production in about three years' time with an initial output rate of 350,000 tons of sulphate of ammonia per year. The magnitude of the project and the extent of the Indian Government's development programme can be the better assessed when it is remembered that India's annual pre-war consumption of sulphate of ammonia was no more than 100,000 tons, of which less than one-third was produced at home.

To Cost £10 Million

Capital expenditure will amount to about £10 millions. Of this sum, more than £4 millions has already been spent in the U.K. on plant and equipment, while design and other work undertaken in the U.S.A. amounts to date to about £800,000. Most of the remaining work will be carried out in India and with Indian personnel and resources.

The manufacturing process to be employed is the generation of semi-water-gas from coke to produce the ammonia, followed by conversion to sulphate by the gypsum process. 500 tons of coke will be gasified each day in the gas generation plant, while nearly 1000 tons of coal will be consumed by the steam plant, the boilers of which will operate at a pressure of 625 lb. p.s.i. to drive turbo-alternators with an installed capacity of 80,000 kilowatts. The gas will be compressed to a working pressure of 5500 lb. p.s.i. by eight compressors, each driven by its own 2500 h.p. electric motor. In the conversion of the ammonia into sulphate, 1500 tons per day of gypsum will be crushed, ground and treated.

Varied Equipment Needed

Other equipment to be installed will comprise refrigeration plant and special high-pressure vessels for the purification and synthesis of the gas, filters for removing the waste chalk, vessels in stainless steel and aluminium for treating and evaporating the liquors and producing crystals, gas-heated rotary driers and coolers for drying the product, and equipment for handling storage and packing of the finished material.

The target at which the Indian Government aims, is 3 million tons of fertiliser per year. Some years must pass, however, before this figure can be reached. It is understood that no definite date has been set for completion of the first plant, but construction of the second will in any case begin in about three to four years.

Safety in Mines

Work of Research Laboratories

A RECENT visit that Mr. Alfred Robens, Parliamentary Secretary to the Ministry of Fuel and Power, has made to the laboratories and mines research stations at Sheffield and Buxton, recognised the acceptance of responsibility by the Ministry as a result of nationalisation. The cost of maintenance is £125,000 per annum.

Constructed between 1925-30, and formerly financed by the Miners' Welfare Fund, these research establishments have a staff of 190, including about 100 scientists and technicians. Their work covers a wide range of pure and applied science, and includes experiments on coal dust explosions, research and tests on haulage equipment. Research into cause and effect of stone dust, with particular emphasis upon the suppression and treatment of silicosis and pneumoconosis is also extensively carried out.

An important part of the work is the publication of research results and acquainting mineworkers of latest developments and discoveries. Wall-charts, notes, booklets, and films are in constant production.

Tin Buying Prices Raised

It is officially announced that the Ministry of Supply's buying price for Malayan tin metal has been increased from £423 to £500 a ton ex smelters' works (Penang or Singapore) and that for Nigerian tin concentrates from £405 15s. to £477 a ton of tin in ore f.a.s. Nigerian port. The selling price of Malayan metal is raised from £426 to £504 a ton ex smelter (Penang or Singapore). The new prices operate as from December 19. (Increased selling prices for Ministry stocks of tin were announced last week.)

AMERICAN COMMENTARY

Aluminium Foil Plant

A GERMAN 32-mill plant, considered one of the most efficient and diversified plants in the world for the production of aluminium foil, has been acquired by the Permanente Metals Corporation, Oakland, California, and represents the first German reparations plant offered to United States industry. The company's high bid for the property to the Foreign Liquidation Commissioner has been accepted and the sale approved by the U.S. State Department. It is expected that the plant will be producing much needed aluminium foil here by next summer.

The Corporation' engineers are to leave the U.S. about January 1 to supervise the dismantling and shipment of the plant to the United States. Officials revealed that the purchase, transportation, import duty and installation of the plant will represent an expenditure of approximately $1 million. The plant was allocated to the United States by the Inter-Allied Reparations Agency after consideration of other governments' claims. In addition to finishing mills, other equipment acquired by Permanente Metals includes remelt furnaces, breakdown and roughing mills, and facilities for colour printing, lacquering and embossing aluminium foil, and glueing the foil to paper.

Atom Bomb "Myth"

MR. David E. Lilienthal, chairman of the U.S. Atomic Energy Commission, warned an assembly in Chicago of 5000 members of the American Farm Bureau of what he called "the myth" of the atom bomb. "That myth," he said, "is this: that atomic energy is useful only in a bomb, a weapon—and nothing else; that it is only in a military weapon that atomic energy has any real importance; that talk about peaceful uses is nonsense. Nothing could be further from the truth.

"Atomic science is not confined to weapons, but opens a new world of knowledge. We are not dealing here merely with a new explosive, with 'just another bomb,' however powerful. You and I are witness, here in our time, of the unfolding of new knowledge that goes to the very heart of all things physical."

As one example of peaceful utilisation of atomic science, Mr. Lilienthal told of its use in agriculture to manufacture "tracers" or radio isotopes which can be followed through a plant.

New Welding Rod

DESIGNED specifically for all types of grey or alloy cast iron and to eliminate the uncertainties and delays of manual fluxing when welding stressed cast shapes, a new colour-matching, flux-coated torch welding rod known as "EutechRod 14 FC" has been produced by the (U.S.) Eutectic Welding Alloys Corporation. This rod develops a tensile strength of 48,000 p.s.i. in the weld deposits, bonding at 950°-1400°F., with a remelt temperature of 2200°F. Its coefficient of expansion is the same as that of grey cast iron, and its hardness is approximately 190 Brinell, producing welds that are fully machinable. The new welding rod, it is claimed, enables fast, smooth welds of cast iron readily to be made with very little fusion of base metal.

U.S. Rubber Consumption

U.S. consumption of natural rubber in October amounted to 56,986 long tons, the largest monthly total for the year to date, and more than 6000 tons higher than the September total. Consumption exceeded supplies by more than 7000 long tons, while stocks at October 31 had dropped to the lowest level yet reached this year, *i.e.*, 114,530 long tons.

Consumption of natural rubber for the ten-month period ended October 31 totalled 454,001 long tons, whereas consumption for the twelve months of 1946 was 277,597. For the ten-month to October 31, 476,984 long tons of synthetic rubber were consumed, and 239,838 of reclaimed rubber, making a total of 1,170,823 for the period as against 1,314,796 for all 1946.

More Oxygen for U.S. Steel

THE oxygen plants of Air Products, Inc., New York, have been enlarged to raise future production as high as 2000 tons per day in some cases. This development is said to be due to anticipated increased demands from the steel industry where an advanced technique using oxygen may raise steel production considerably.

S. African Business Developments

A new holding company known as Incorporated Industries, Ltd., recently formed in Cape Town with a capital of £1,250,000, has now acquired the Rely Paint & Metal Works, Paarden Elland, Cape Town.

The latest annual report of the Pretoria Portland Cement Co. shows that during the year there was an increase of £83,000 in the profits as compared with the previous year, the total being £357,131 after taxation. The dividend at 5s. 6d. was 3d. per share higher.

Sprayed Zinc

Experimental Use on a Bus

FOR the first time in this country, a utility model bus is being sprayed with zinc so that the bodywork may last longer. The operator uses a British manufactured pistol continually fed with zinc wire which it atomises and fires on the surfaces previously blasted with steel grit. Mr. J. W. Harrop, director of the firm, Merseyside Metal Sprayer, Ltd., which is carrying out the work, said:—"I have estimated that it will take two-and-a-quarter miles of wire to the inside and outside of the bus. We have used the process in ship work and structural work but never before on a bus." An official of Birkenhead Transport Department said that the normal life of a bus body was 10 to 12 years. The life of the wartime utility models, with steel instead of aluminium bodies, was said to be four years. Now, in view of the economic situation, they were trying to make the utility models last as long as a normal bus. At the end of the four years it would otherwise have cost £900 to recondition the body. The metal spraying process would cost about a tenth of that sum.

Jute Research Centre

Staff Appointments Pending

THE jute industry plans the erection of a special building designed specifically for the development of a research programme aimed at jute development. This is one of the principal recommendations of the British Jute Trade Research Association. Such a site will, it is hoped, be available within a period of months, permitting an early start to research work in detail. One other delay, noted at the annual meeting in Dundee, is that some 80 per cent of the necessary equipment for the station cannot be supplied under 18 to 24 months. Research work is to begin in temporary premises and staff will be engaged early in the New Year.

Three of the Advisory Panels have now been drawn up and a programme of applied research approved. Mr. H. Corteen, director of research, has indicated a number of problems which he regards as essential research problems in order that the industry may benefit to the maximum extent. Work on these will be a first interest of the association.

Glass Fibre Development.—An important development of the glass silk industry is foreshadowed by the decision of Chance Bros., Ltd., to expand their Fibreglass, Ltd., plant in Glasgow. An expanded factory of 90,000 sq. ft. will manufacture continuous filament fibres for the textile industries.

Benzole Production Down

Official Encouragement Lacking

IN his address to the 25th annual general meeting of The Midland Tar Distillers, Ltd., at Springfield Chemical Works, Birmingham, last week, Mr. Stanley Robinson, chairman, reminded shareholders that at last year's meeting he had told them that the production of crude benzole was being greatly reduced.

"Today," he continued, "even less is coming forward, and the refining of benzole plays a much smaller part in our affairs than it should. We hope that the 'powers that be' will appreciate the value of this home-produced motor spirit, and that steps will be taken to encourage the gas industry by every means possible to restart their benzole washing plants."

Mr. Robinson added that the company had increased its production of tar acids, which he believed would continue to find an expanding market, both for export as such, and as a raw material for synthetic resins and the plastics industry. Large quantities of creosote were continuing to be supplied to Imperial Chemical Industries, Ltd., for hydrogenation. During the year, large quantities of creosote had been sent to the U.S.A. and other countries.

Scottish Furnaces Idle

Shortage of Scrap

AT least six open hearth steel melting furnaces were stated last week to be out of commission in Scotland because of the lack of raw materials such as heavy scrap.

The most serious loss to production was the big tilting furnace at Clydebridge Steel Works, Cambuslang, which handles up to 300 tons of metal at a time, and can turn out about 2000 tons of ingots a week. The furnace is the only one of its kind in Scotland, and one of the largest in Britain.

The other idle units were four fixed furnaces at Dalzell Steel Works, Motherwell, and one at Glencarnock Steel Works, Ayrshire. Each of them is capable of melting 1000 tons or more a week. Smaller furnaces in the other Scottish steel plants are also severely hampered by the same cause.

Light Metal Statistics

Production, consumption, imports and uses of light metals in the U.K. for the month of October, are announced by the Ministry of Supply as follows (in long tons):—

Virgin aluminium: Production 2418, imports 13,290. *Secondary aluminium*: Production 10,246. *Uses (aluminium scrap arisings)*: 12,030, consumption 8922. *Aluminium fabrication* 20,784. *Magnesium fabrication*: 294.

ITALIAN WORK ON BUTADIENE

Selective Hydrogenation of Di-olefins

WHEN olefins are obtained by pyrochemical or cracking methods it is often necessary to eliminate some di-olefins, which are objectionable for various reasons. One method of removal is by selective hydrogenation of the di-olefins to olefins, which has hitherto been done with rather expensive catalysts of the palladium type. G. Natta and co-workers at the Milan Polytechnic have recently studied other catalysts obtained from common metals, especially nickel oxide in a highly dispersed condition. (*La Chim. e l'Ind.*, 1947, *29*, 235-7).

THE production of butadiene from ethyl alcohol and acetaldehyde, generally in the proportion 2 : 1, with special catalysts, such as alumina (from aluminium sulphate) activated by chromium oxide, has been the subject of prolonged and fruitful study by R. Rigamonti and others at Milan Polytechnic. The importance of the Italian work resides largely in the light thrown on catalysts resistant to ageing and poisoning giving larger and more selective yields of butadiene in a tubular furnace with mercury vapour at 360° C. The further stage in the work summarised here is devoted to the associated problems of eliminating unwanted products and the use of alternative catalysts.

A review of the literature shows that quantitative hydrogenation of di-olefins of the butadiene class to olefins has been achieved only by chemical means, using sodium or amalgam, or catalytically through the higher homologues of butadiene. The present study, however, relates to selective hydrogention of simple di-olefins—butadiene and piperilene, both in the liquid and the vapour phase—but has included also mixtures of mono- and di-olefins as well as the simple substance.

Pure metal catalysts were not used; only those obtained from dispersed oxides such as the chromites of copper, copper and zinc, or nickel and zinc on a kaolin support, obtained from the respective chromates by precipitation and reduction at 350-400°C. Of these the chromite of nickel and zinc gave maximum selectivity.

This work is a continuation of that previously carried out by the authors with acetylene and ethylene, forming the subject matter of two Italian patents, No. 397,287 (1942) Appln. No. 11056 of 27.3.47.

With the nickel and zinc chromite catalyst there was complete hydrogenation of butadiene to butylene with minimum formation of butane, or none at all. This was in the vapour phase with which the best results were obtained.

In similar tests with piperilene, a mixture of pentenes, piperilene, and ethyl ethers—resulting as by-products in the production of synthetic rubber at the Ferrara works—was used, either as such or after treatment with concentrated HCl to remove the ethers.

Operating in the liquid phase under 150 atm. pressure was first tried, but proved unsatisfactory because there was almost invariably complete hydrogenation to pentane. Much better results were obtained in the vapour phase. According to the method of working, and because of difference in b.p. of pentene and pentadiene, mixtures were obtained in the final results of varying ratio of mono- and di-olefins. Once again the zinc-nickel catalyst gave the best results and proved most selective in action, while the copper catalysts were inferior.

With regard to the effect of some carbon monoxide in the hydrogen, this as usual proved a poison, especially with the nickel catalyst; it is further stated that 5 per cent of CO in the hydrogen slowed up the hydrogenation and did not increase the selectivity of the catalyst.

Study of Catalysts

In continuation of previous work referred to, G. Natta and R. Rigamonti have subjected their silica-magnesia catalysts to careful X-ray and other examination, with interesting results. (*La Chim e l'Ind.* 1947, *29*, 239-243.)

Generally it may be stated that such examination reveals the formation of a magnesium silicate which tends to reduce catalyst activity and lower yields of butadiene; attempts have therefore been made so to prepare the catalyst that liability to form silicate is practically eliminated.

After noting the many causes of variation in catalytic activity—now well known—the Italian authors point out that during the preparation of the silica-magnesia sludge or paste some heat is developed, as had been previously noted by the Russian workers. This may be due to various concomitant causes such as absorption of water by the silica, conversion of magnesium oxide to hydroxide, and combination of silica with magnesia. The last two probably predominate. Various combinations of silica and magnesia are already well known, dating back to Lemberg's observations in 1872.

(*Continued on page* 818)

SYNTHETIC GLYCOLS

Germany's Varied Products of Invert Sugar

"GLYCEROGEN," a glycerol substitute consisting of glycols, glycerol, erythritol, and other compounds, was manufactured in Germany by the continuous hydrogenolysis of invert sugar by the I.G. Farbenindustrie, according to an American report describing the manufacturing process prepared by the late Dr. R. Max Goepp, Jr., an organic chemist formerly employed by the Atlas Powder Company of Wilmington, Delaware. The 51-page report, which has just been placed on sale by the Office of Technical Services of the U.S. Department of Commerce, states that the process "is of considerable technical interest in that it represents the only large-scale application of continuous hydrogenolysis of sugars at elevated temperatures and pressures."

35 Per Cent Glycols

The glycerol substitute, "glycerogen," consists of about 35 per cent glycerol, 35 per cent glycols, and 25-28 per cent hexitol, the report states. The I.G. Farben plant at Hoechst produced about 250 tons of it a month, using a high pressure continuous hydrogenolysis process originally developed at the I.G.F. Ludwigshafen plant. The monthly output was never increased because the product then had not sufficient commercial value.

The development of glycerol substitutes in Germany was approached from many directions, according to the report. For example, the synthetic fats programme called for chemically pure glycerol for which the "Oppau process," involving propylene chlorination and hydrogenolysis, was developed. For alkyd resins, the functionally related trimethylol propane process achieved considerable success. However, for the numerous softening and conditioning uses of glycerol in tobacco, cellulose films, cosmetics, and pharmaceuticals, the chemical identity of the product with glycerol was immaterial, so long as the substitute had the proper viscosity, taste, lack of colour, and was non-toxic.

Several years of experimentation with small-scale equipment showed that invert sugar could be cracked to give mixtures averaging 35 per cent each of glycerol and glycols (largely propylene glycol), and 25-28 per cent of a non-volatile, six-carbon residue. The material was colourless, reasonably sweet in taste, non-toxic, and resembled glycerol in viscosity. In 1937 the decision was made to adopt long, unstirred, liquid phase reactors, agitated by circulated hydrogen. In 1938 the present plant at Hoechst was constructed for a 250-ton monthly production level.

Commercially, however, glycerogen has never been regarded as more than a substitute for glycerol. Considerable difficulty has been experienced in its manufacture, particularly in learning how to prevent corrosion and stoppage of the reactors by the suspended catalyst and how to accomplish pressure release without damage to pumps. Of technical interest, however, is the fact that the process applies continuous catalytic hydrogenolysis to sugar at a temperature of 200°C. and a pressure of 325 atm. "In view of the general applicability of the techniques involved, it has seemed worthwhile to study the glycerogen process in greater detail than that hitherto reported," Dr. Goepp's report states.

The full report, No. PB-803993, entitled The I.G. Hoechst Glycerogen Process, discusses the chemistry of the process in outline, the direction of flow and type of equipment used in inversion, reduction and cracking, recovery, general layout of the Hoechst plant, catalyst preparation, production and cost data, and the composition, properties and uses of glycerogen. Nineteen drawings and tables are included, illustrating inversion, make up, reduction and cracking, recovery, separator valves, reducing, pressure release and angle-stop valves, and other details of the operation.

Rumanian "Oil Grab"

Flimsy Charges Against Managements

IN an attempt to justify its appropriation of the two local oil companies, largely British-owned, the Rumanian Government has preferred a number of accusations against the managements, the text of which was released last week.

The two companies concerned are the Astra Romana, 72 per cent of whose shares are held by Royal Dutch, and Unirea, which is almost entirely owned by British shareholders. Before the war the output from these companies represented almost half Rumania's total oil production.

The main charges against them were that they did not observe the terms of their contracts in regard to the methods of extraction of oil, and had not fulfilled the production quotas allocated to them under Rumania's economic five-year plan. They are also charged with collaboration with the Germans during the occupation. None of the British personnel was in Rumania during that period.

Austrian Scientific Instruments

Gradual Revival of Zeiss and Schott Works

From a Special Correspondent

ACCORDING to reports received in London, the Carl Zeiss Foundation of Jena, which embraces the well-known Zeiss optical works and the Schott glass works, has resumed its production of lenses, measuring and other scientific instruments on a considerable scale. It is stated that a minimum reconstruction programme has been completed and that a new production plan, drawn up for next year, envisages an output not far below that of a normal pre-war year.

The removal of plant to Russia appears to have been quickly overcome. Confiscations from the Zeiss and Schott works at Jena, Saalfeld, Gera and Pössneck, decreed by the Russian occupation authorities in October, 1946, assumed very large dimensions. Zeiss retained only about 6 per cent of its plant—only 573 operable items of machinery, 480 items in need of repair and some 100 items on loan.

From the Schott chemical glass works, all major items of machinery were removed, including the vital power plant. About 270 members of the Zeiss staff, and about 15 employees of Schott went to the Soviet Union, where they were reported to be active in the re-erection of the plant removed from Jena. It appears that this plant is being reassembled in the vicinity of Leningrad, Moscow and Kiev.

It has since been reported that the removal of plant was stopped in December of last year when the whole policy was reversed by a new Russian order pertaining to the reconstruction of the works. It was apparently found that the difficulties connected with the reassembly and subsequent operation of such a highly complex manufacturing unit as the Zeiss-Schott works were insuperable.

At the Zeiss works, attention is being concentrated on photographic lenses and other components which are being delivered to the various camera makers in Saxony. Other optical products, especially microscopes, are also being made. Another important section of the works is again actively engaged in the manufacture of scientific apparatus, measuring instruments for industry, notably for the food industries, etc. The Schott works are manufacturing chiefly optical glass (the annual capacity of the works totals at present some 180 metric tons), glassware required in industry, while the manufacture of sheet glass is to be resumed at a later date.

Although the greater part of Zeiss's output is being taken as reparations, a certain quantity is being exported in exchange for raw materials, notably for chemical products. Future expansion will be carefully watched by all those countries which have set up their own industries in order to become independent of Zeiss products.

ITALIAN WORK ON BUTADIENE—(*from page* 816)

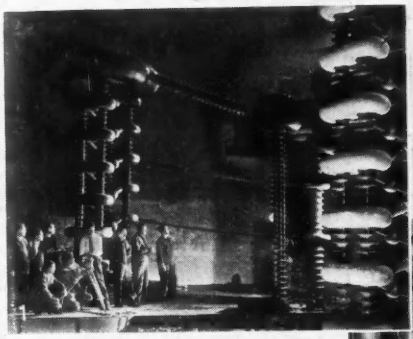
X-ray examination was made of the raw material used, of catalysts freshly prepared under various conditions, and of calcinated and used catalysts. More specifically the tests included unused catalysts prepared cold, prepared cold and calcinated, prepared hot, and finally, used catalysts. These X-ray tests were supplemented by chemical analysis, which permitted the following conclusions:—

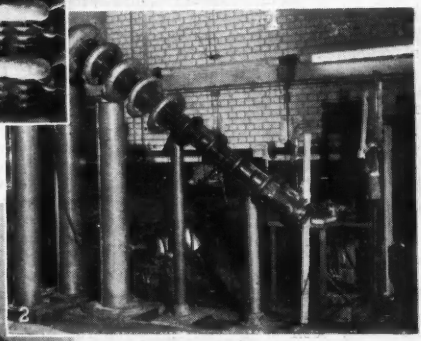
Magnesia and silica in prolonged contact with water (and more rapidly when hot) react to form amorphous silicates which crystallise on heating (calcinating) above 700° C. All catalysts after a certain period of use show more or less intensely, under X-ray examination, the crystal silicates line; those which show it most intensely give low yields of butadiene; while those with which the line is less intense give higher yields.

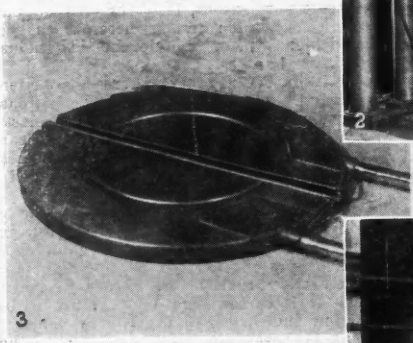
Chemical analysis confirmed the X-ray results in respect of the relation between silicates content and catalytic activity, and has moreover shown that diminishing yields through ageing and use of catalyst are related to a marked increase in magnesium silicate content. On the other hand, a partial reaction between silica and magnesia, leading to the initial stages of setting or solidifying the paste, necessarily results, since all the tests with catalysts prepared dry or impasted with alcohol showed low yields.

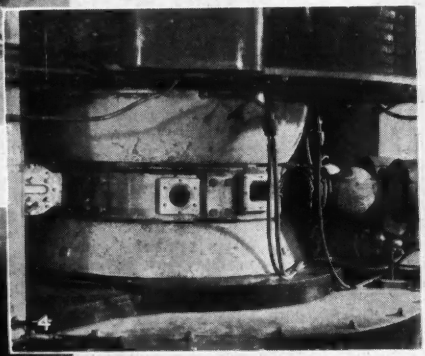
Experiments were made in the preparation of catalysts by impasting with solutions containing positive magnesium or negative hydroxyl ions, so as to reduce solubility of the magnesium hydroxide and therefore the silicate formation. Such catalysts have given yields clearly superior to those obtained with catalysts prepared with water only.

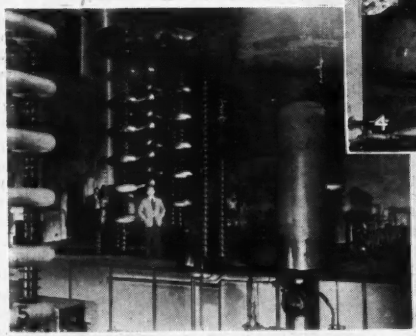
On the basis of these experiments, catalytic activity should be attributed—when used for butadiene production—to the presence of magnesia finely dispersed and in part absorbed by the silica. But the amount of magnesia should not be excessive otherwise the whole surface of the silica particles is liable to be successively transformed into silicate.











FIRST "ATOM" FILM

1. G.-B. Instructional Film Unit dwarfed by the gaint h.t. equipment they went to film in the Cavendish Laboratory. 2. The linear proton accelerator at the Imperial College of Science employing 600,000 e.v. to disintegrate atoms

3. The cyclotron "DEES," employing a semi-circular hollow electrode to promote extremely high energy in the atomic stream. 4. The 10 million v. cyclotron at the Cavendish Laboratory. 5. The film director plans future shots in the h.t. room at the Cavendish Laboratory

CHEMICAL PRODUCTS OF CARBONISATION—I

Rich Sources of Versatile Organic Materials

by JOHN R. CAMPBELL, B.Sc., Ph.D., A.R.T.C. F.R.I.C.

IN this country, the liquid products derived from the carbonisation of coal have been the source of our organic raw materials for the last century. As a consequence, since the composition of these liquid products is essentially aromatic, developments in the field of organic research and of the organic chemical industry have during that period been concentrated largely on derivatives of benzene, toluene and their homologues.

On the other hand, within the comparatively short lifetime of the petroleum industry, there has arisen in America a new branch of the chemical industry based on the aliphatic hydrocarbons, more especially the lower members of the paraffin, olefine and acetylene series which are present in, or can be produced with comparative ease from, the oil and natural gas associated with it. On the Continent, too, within recent years, developments in the organic chemical industry have been mainly on the aliphatic side, principally as a result of the vast production of synthetic oil which took place and which made available considerable quantities of these lower aliphatic hydrocarbons.

Chemicals from Petroleum

It has been demonstrated by American oil practice that it is a relatively simple matter to convert the lower paraffins by cyclicisation to yield aromatic hydrocarbons, so that any country which has ample resources of the lower aliphatic hydrocarbons is therefore in the fortunate position of having the raw materials to supply both the aliphatic and aromatic chemical industries.

At the present time, then, countries such as the oil-producing countries, which possess the raw materials for both industries, are at a considerable advantage over others in which developments have been limited to the aromatic chemical industry because, even although benzene and its homologues were available in sufficient quantities, which, in this country at least is not the case, it is not so easy to convert the cyclic compounds into the necessary non-aromatic hydrocarbons.

In Britain the aromatic chemical industry is capable of absorbing all the aromatic raw materials at present being produced. It follows, therefore, that there must be established with the utmost speed, a source of the lower aliphatic hydrocarbons to meet the needs of the newer organic chemical industries if this country is to maintain its position in the chemical industry of the world. The inherent difficulty in Britain is that, apart from minor petroleum deposits and a certain amount of natural gas consisting largely of methane, developments must necessarily be based on our reserves of coal.

Coal is undoubtedly our most important industrial asset and formed the source of power on which the industrial success of this country was built. While the main function of coal in the past has been to provide power and heat, a function which it will continue to fulfil in the future to a considerable extent, it is our only abundant source of carbon and is therefore the basis on which all our organic chemical industry must be built.

Within recent years there has arisen a growing necessity for the supply of aliphatic chemicals for the newer industries, plastics, synthetic rubber, artificial fibres, lubricants, synthetic fuels, etc., and these of necessity must largely be, and can be, provided by coal and its products.

The carbonisation industry is the one which can correctly be said to process coal on the largest scale but the organic chemicals at present derived as by-products are essentially aromatic in nature. Nevertheless, it is to the high temperature carbonisation industries that recourse must be made to seek the raw materials without which the modern organic chemical industries cannot be developed.

Three Main Products

High temperature carbonisation of coal produces three main primary products, coal, gas and tar, each of which constitutes a potential source of raw organic chemicals. The coke produced is comparatively non-reactive, the tar is essentially aromatic, while the hydrocarbons in the gas are of a relatively simple aliphatic type belonging to the paraffin and olefine series, although a little benzene and toluene may be stripped from the gas by suitable methods.

These products, then, are the starting materials upon which the organic chemical industry of this country so largely depends. While it is not yet clear just what part the carbonisation industries will play in providing those materials, it is advisable that they should recognise the potential demand for these compounds in the near future and realise to what uses the various substances may be put.

Since the coke produced by high temperature carbonisation of coal is of comparatively low reactivity, methods for its conversion into more useful chemicals are, of necessity, usually of a vigorous nature and, in general, involve the conversion of the carbon into some other relatively simple organic compound which can then be made to react to yield the desired product, *i.e.*, the conversion from coke to chemical requires at least two separate chemical reactions involving the preparation, if not the actual isolation, of an intermediate product.

An important example of this type of successive reaction is furnished by the Fischer-Tropsch synthesis, the reactants for which consist of a mixture of carbon monoxide and hydrogen in proportions which vary according to the nature of the final product required.

Water Gas

Water gas, prepared from coke by methods well known in the gas industry, contains the two gases in approximately equi-molecular proportions but the ratio of hydrogen to carbon monoxide can readily be increased at the expense of the carbon monoxide by making use of the water gas equilibrium—

$$CO + H_2O \rightleftharpoons CO_2 + H_2$$

the resulting carbon dioxide being removed by scrubbing with water under pressure.

By the use of suitably purified synthesis gas mixtures of hydrogen and carbon monoxide, and under the right conditions of pressure and temperature and in presence of catalysts, synthesis of the Fischer-Tropsch or Robinson-Bindley type can be made to yield such diverse products as methanol, aliphatic hydrocarbons and acids, and ultimately edible oils. The various aspects of the Fischer-Tropsch synthesis, however, have been dealt with so fully recently that there is no necessity to enlarge on it further.

Coke is also the primary material for the manufacture of hydrogen for the many hydrogenation processes which are now commonplace, although in certain cases alternative methods are available. Once again, water gas is the intermediate product in its conversion to hydrogen and in this case all the carbon monoxide is converted catalytically into carbon dioxide and hydrogen by making use of the water gas equilibrium and subsequently removing the carbon dioxide, as before, by scrubbing with water.

Final traces of carbon monoxide are removed by washing the gas with solutions of cuprous ammonium salts under high pressure. Included in the products of hydrogenation are methane, petrol, hard fats and ammonia, all of which are of great importance in the present national economy.

The hydrocarbons in the gas formed by the straight high temperature carbonisation of coal are essentially aliphatic in nature and, unless oil refining is practised on a large scale, coal gas will constitute the major source of these chemicals in this country.

Straight coal gas (*e.g.*, coke-oven gas) has the following approximate composition:

		%	B.P.
Butylene	...	0.05	−6° C.
Propane	...	0.15	−42°
Propylene	...	0.40	−47°
Ethane	...	0.85	−88°
Ethylene	...	2.5	−104°
Methane	...	28	−161°
Hydrogen	...	50	−253°

the remainder consisting of nitrogen, oxygen and oxides of carbon. This composition will vary within narrow limits with different coals and different conditions of carbonisation.

The hydrocarbons, as also indeed the hydrogen, form a valuable source of raw materials for aliphatic synthesis which could be built up on a parallel with that which has been developed in the U.S.A. from the natural gas in the oilfields. Isolation of the hydrocarbons from coke-oven gas has been extensively practised on the Continent.

Coke-oven gas is perhaps more suitable than gas-works gas for the separation of the hydrocarbons, for two reasons. In the first place, since the supply of coke-oven gas is not dependent on fluctuating seasonal demands the composition and output of gas remain reasonably constant. Secondly, the same limitations are generally not imposed on the calorific value of the gas as is the case with town gas supply.

Suitable Starting Points

Nevertheless, there is no reason why these hydrocarbons could not be separated equally well from ordinary town gas. Removal of the olefins from coal gas by refrigeration would result in the simultaneous removal of the paraffin hydrocarbons with the exception of methane. This would involve a sacrifice of the highest calorific value components of the gas and would result in a reduction of the calorific value of the straight coal gas from about 570 B.Th.U. per cu. ft. to about 520 B.Th.U. per cu. ft., *i.e.*, by about 9 per cent. The yield of gas would be reduced by about 4 per cent, resulting in a decrease in gaseous therms of the order of 12 per cent.

On account of its high concentration it would appear that the most desirable hydrocarbon for isolation would be methane, but of all the hydrocarbons normally encountered in the carbonisation industry, methane

(*continued overleaf*)

Atomic Energy in India

Rich Thorium Deposits to be Exploited

INDIA possesses the richest known deposits of thorium as well as some uranium, and will direct her atomic energy research "entirely towards industrial and scientific purposes and not towards the production of atom bombs." Although uranium was used to make the atom bomb, American scientists have reported that a thorium/uranium combination can maintain a chain reaction too. A survey of India's important minerals is therefore being undertaken by the Government of India to determine the extent of thorium deposits lying in the State of Travancore, and whether the uranium is present in usable quantities.

Control of Thorium

The Government is already attempting to implement its atomic energy policy by negotiating an agreement with Travancore Government for joint control of thorium and similar radio-active minerals. This will seek to vary an announcement by the Travancore Government last summer prohibiting exports of the thorium bearing monazite sands which extend for 150 miles along its coast.

Scientists working at Bombay laboratory have developed a new and cheap method of separating thorium nitrate from monazite sands by modifying and combining two previously known principles. Cyclotron experiments have already been started in Calcutta where there are two more laboratories, and a fourth is expected to be established at Travancore itself. Later, the so-called "pile" experiments for production of atomic energy on a small scale may be started in Bombay.

Centralised Research

A notable event in India's atomic energy programme is the setting up of a board of research under the auspices of the Council of Scientific and Industrial Research with Prof. Homi Bhabha as chairman. A joint committee comprising six members of the board and three representatives of the Travancore Government has been constituted to advise both the Government of India and the Government of Travancore on all matters connected with research and development and use of raw material.

The committee will thus be the authoritative advisory body for both the Governments. Membership is as follows: Prof. H. J. Phabha (chairman), Prof. Meghnad Saha, Mr. D. N. Wadia, Dr. Nazir Ahmed, Dr. K. S. Krishnan, Sir S. S. Bhatnagar, Dr. K. L. Moudgil, Dr. K. P. P. Menon and Mr. V. Mahadevan.

CHEMICAL PRODUCTS OF CARBONISATION

(*continued from previous page*)

is by far the most difficult to convert directly into useful derivatives. Consequently, the separation of ethylene presents certain attractions although it is present in coal gas in a concentration less than one-tenth that of methane.

Extraction methods are based usually on one or other of three techniques (a) scrubbing with benzole under pressure, (b) adsorption on active carbon under pressure, or (c) liquefaction followed by fractional distillation. If the separation of both methane and ethylene were carried out, the methane isolated would compensate, at least in part, for the lack of a carbide industry in this country since methane can be converted into acetylene by cracking in the electric arc or by controlled oxidation.

Separation of these gases would thus lead to a supply of methane, ethylene and acetylene, the primary members of each of the three aliphatic hydrocarbon series.

In addition, of course, separation of these gases by liquefaction would also yield small quantities of ethane and propane, together with propylene and butylene, all of which are valuable starting materials in the chemical industry. The residual gas would be rich in hydrogen and, after adjustment in composition, could be used for one or other of the various hydrogenation processes, including ammonia synthesis. It would not be economic, of course, to practise the isolation of these hydrocarbons in all gas manufacturing installations. A limiting size of plant exists below which it would not be advantageous to attempt any separation, but it has been estimated that a coke-oven installation with a daily throughput of 1000 tons of coal would produce 10 tons of ethylene, at least half of which could be recovered.

Conversion of this into some transportable intermediate such as glycol or even into polythene would appear to be an economic possibility. It is obvious that some preliminary treatment of the extracted gas must be carried out at the extraction plant owing to difficulties in the transport of the isolated gases, ethylene, for example, having a critical temperature of 9.7° C.

These gases, then, methane, ethane, propane, ethylene, propylene and butylene constitute the potential raw materials which could be supplied by the carbonisation industries to the chemical industry. How some of these starting materials have been developed within recent years will be discussed in the ensuing sections of this paper.

(*to be continued*)

Current Efficiency in ElectroChemistry

New Measuring Process Developed in the U.S.A.

A NEW method for measurement of the current efficiency of an electrochemical process in connection with electrochemical studies of isotopes has been revealed this week by the U.S. National Bureau of Standards. The method, developed by Mr. W. J. Hamer, is based on principles previously utilised at the Bureau in the separation of natural isotopes by a technique known as countercurrent electromigration, in which an imposed flow of electrolyte through a packing in a direction opposite to ionic migration carries back the slower moving ions of the heavier isotopes. (THE CHEMICAL AGE, August 23.)

Eectrochemical processes are increasingly being used in industry for the preparation of a variety of materials.. Chlorine and other gases, including a number of paraffin hydrocarbons, are obtained in this way and electrochemical processes are also employed in the electro-refining of metals and in electrolytic oxidations or reductions.

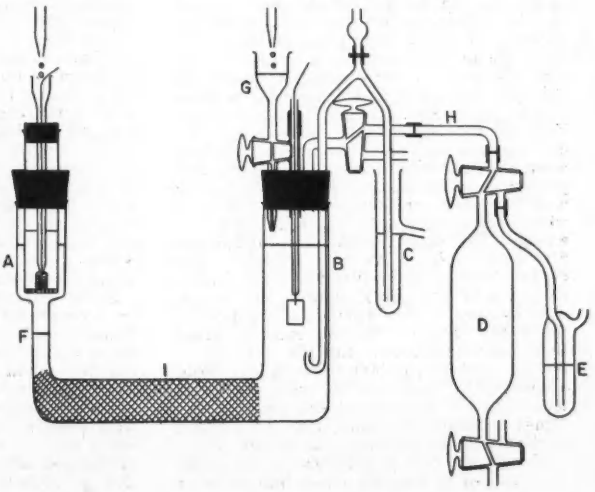
Basis of Measurement

In many of these processes simultaneous reactions take place at an electrode. Where this occurs, the ratio of the number of equivalents of a single electrode product to the total possible number represents the current efficiency of the electrochemical process under investigation. Variations usually occur in ionic composition or concentration in the vicinity of the electrodes, due to electrolysis and ion transport. Because of such variations, precise values of the current efficiency cannot be obtained, and the process cannot be carried on continuously with either constant current efficiency or constant yield.

For example, when a concentrated solution of brine is electrolysed between graphite electrodes, a gaseous mixture of chlorine and oxygen is generated at the anode. At first, this mixture may contain 98 per cent chlorine and 2 per cent oxygen; the current efficiency for the production of chlorine would then be 98 per cent. However, as electrolysis proceeds, the concentration of chloride ion in the brine becomes less from loss of chlorine gas, and the current efficiency for the production of chlorine decreases correspondingly, eventually becoming almost zero. Mixing of the products at the electrodes also lowers the efficiency of the process. As a result, the overall efficiency may be only 50 per cent, with an attendant increased cost of production.

Many types of electrolyte cells have been used commercially to increase current efficiency in the production of chlorine gas—a result that also may be achieved with the apparatus developed at the National Bureau of Standards. This apparatus consists essentially of a cell with flowing electrolyte, in which there is no net transfer of ions and in which the concentration of the electrolyte is kept constant during the electrolysis. Current efficiency is thus maintained at the initial level.

(Continued overleaf)



Principal components of the electrolytic cell shown in plan here are: A cathode compartment; B anode compartment, separated by glass wool packing; C siphon overflow; D evacuated pipette; E and H trap and tube; F level of electrolyte; I glass wool

ELECTRON DIFFRACTION CAMERA

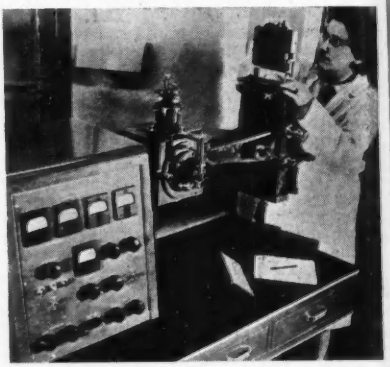
IMPROVED MEANS OF STUDYING SURFACES AND FILMS

A NEW research tool designed to aid in the observation and measurement of surface conditions of metals, ceramics and plastics is an electron diffraction instrument, particularly valuable in the investigation of problems associated with corrosion, catalysts, lubricants, metallurgy, pigments, surface deposits, and graphite. It differs from the X-ray diffraction instrument, which analyses thick specimens, in that the new instrument shows the crystal structure of surfaces and thin specimens up to 500 Angstrom units. Its production is being undertaken at present by the Special Products Division of the U.S. General Electric Company.

In operation, a beam of electrons is directed at the specimen being tested, and any resulting diffraction is photographed. The pattern consists of rings whose diameter, intensity, and orientation provide information for determining composition, orientation, and size of the crystals present.

The instrument consists of one unit containing a vacuum chamber with specimen manipulator, visual and photographic recording camera, electron gun and beam focusing elements, regulated high voltage power supply, and complete vacuum pumping equipment.

The specimen chamber permits examination of specimens ranging from 0.1 to 4 in. in diameter. In many cases, the instrument will detect and help identify the very first chemical changes before they are visible under a microscope or are detectable by other means.



CURRENT EFFICIENCY—

(*continued from previous page*)

The apparatus has been used with various concentrations of electrolyte, in the electrolysis of uranyl chloride. The process takes place within a U-shaped electrolytic cell.

The cell consists of a cathode compartment and an anode compartment, separated by glass wool packing (I) to prevent diffusion of electrolytic products from one electrode to another. For a study of current efficiency in the electrolysis of uranyl chloride, the cell is first filled with the electrolyte up to the level (F). A solution of hydrochloric acid is then poured into the cathode compartment, forming a boundary with the uranium chloride solution; this prevents contamination of the electrolyte with reduced products of the chloride which might form at the cathode. Finally, enough of the chloride is added to fill the cell. As electrolysis proceeds, known concentrations of hydrochloric acid and uranyl chloride are added, drop by drop, to the cathode and anode compartments respectively, at rates securing that the concentration and *p*H of the electrolyte remain constant, the excess being automatically siphoned off into the overflow. When the *p*H of the overflow becomes constant, indicating that the solution in the anode compartment has become saturated with chlorine gas, the gas in the anode is permitted to flow for about half an hour through a tube to a trap to flush out all confined air. Samples of the gas are then slowly drawn into the evacuated pipette; at the same time the solution in the overflow is automatically drawn back into the anode compartment. The current efficiency of the process for the production of chlorine is determined from analysis of the collected gas by absorption in potassium hydroxide.

When platinum and other metals of the platinum group were used as anodes, analysis of the evolved gas showed about 97, 88, and 45 per cent chlorine, respectively, for 0.9-, 0.5-, and 0.1-normal solutions of uranyl chloride. The yield of chlorine was somewhat less with anodes of baser metals such as magnetite, metallic carbides, and graphite. The percentage of chlorine in the evolved gas is independent of current density except for the most dilute solution, where a decrease in current density increases the percentage of chlorine.

Since production of chlorine by electrolysis or uranyl chloride may thus be continued indefinitely under controlled conditions, the method might well be adapted to the production of gases, such as chlorine, hydrogen, deuterium, and oxygen, in lots of known purity. It is also expected that, with some mechanical changes, these principles may be applied in the continuous refinement of metals and in electrolytic oxidation or reduction processes.

Reviving Polish Chemical Industry

Acid and Fertilisers Substantially Increased

THERE has been a steady increase of chemical production in Poland during the second half of 1947, as shown by the following review of statistical data covering the third quarter of the year.

Production of sulphuric acid reached a level of 14,398 metric tons during the third quarter compared with 8868 tons in the second—an increase of 62.5 per cent. Although still lacking sufficient supplies of this acid, the Polish artificial fertiliser industry has been able to raise the output of superphosphates to 56,234 tons, an advance of 45 per cent on the preceding quarter. Resumption of production by the State Nitrogen Works at Moscice has resulted in a 59 per cent rise in the output of nitrogenous fertilisers during the third quarter, when 21,208 tons were produced compared with 13,301 tons in the second quarter.

The importation of a large consignment of technical fats has had a favourable effect on soap production which expanded by 86.5 per cent. Other percentage increases are as follows: Benzol, 17; dyes, 24; explosives for mining industries, 15.5; carbon electrodes, 35; tyres, 17; belting, 35.

Near Pre-war Level

The Polish chemical industry's output in July amounted to 45,600,000 zl. (£1,750,000 at the 1937 rate of exchange). It rose in August to 51,400,000 zl. (£1,970,000) which brought it close to the average pre-war level. The September figures (44.8 million zl. (£1,720,000) are not final and may be subject to upward adjustment.

The employment level in the Polish chemical industry, which rose from over 41,000 persons in the second quarter of 1947 to over 44,000 in the third quarter, is attributable not only to the general increase of production but also to the expansion of capital investments.

Two noteworthy events in the period under review have been the re-opening, several months ahead of schedule, of the State Nitrogen Works (Panstwowe Fabryki Zwiazkow Azotowych) at Chorzow and Moscice. Production of nitrogenous fertilisers began by the middle of July, and chlorine a month later. During August and September the Moscice works manufactured 6470 tons of nitrogenous fertilisers.

Work is also in progress on the expansion or restoration of production facilities for soda (Matwa and Borek), sulphuric acid (Gliwice and Gdansk), carbide (Borek), coal derivatives (Gliwice), organic products (Rokita and Boruta works at Brzeg) and pharmaceuticals (L. Spiess Works at Tarchomin, near Warsaw). Credits allotted for works construction under this heading total 589 million zloty (£368,000).

During the latter part of 1947 the Polish chemical industry has added to its production list several important items. These include sulphur chloride (Rokita Works); sodium acetate (the Grodzisk concern); mono-nitrobenzene (Wola Krysztoforska); para-phenetidine (Boruta Works-Zgierz); sodium perborate (Czarna Huta) and various potassium compounds (the Azot concern). The increasing demands for chemicals for the home and export markets has been reflected both in increased sales and output. The value of sales in the period under review amounted to over 8800 million zl. (£5,500,000), an increase of 20 per cent over the preceding quarter. Chemical exports in the July-September period were worth 1,085,578 U.S. dollars, and represent an increase of 75 per cent over the April-June period. Among the new overseas buyers are the United States and Palestine.

The principal difficulties facing the Polish chemical industry are the shortage of home- and foreign-produced raw materials, and the high rate of wear and tear of installations.

Private Enterprise

In addition to the State-owned industry there are about 1400 privately-owned chemical works—mostly situated in Warsaw and the west-central region of the country—which employ some 10,000 workers, and enjoy a turnover equivalent to about £6,250,000. The range of products of privately-owned concerns is not extensive, the chief activities being production of soap, scouring powders and detergents. There are 345 factories engaged in this work, and they employ about 20 per cent of the total labour force used by private enterprise. The scale of other sections of the Polish chemical industry can be assessed from the following table:—

	Works	Employees
Shoe and floor polishes	230	1,600
Cosmetics	115	700
Paints and varnishes	58	600
Turpentine	13	260

Considerable interest attaches to the discovery of potassium salts at Klodawa, in the Lodz province. In view of the serious shortage of fertilisers it is thought that the exploitation of these resources may ease the difficulties of Polish agriculture. War-time geological investigations undertaken by the Germans indicated that a broad belt of salt-bearing strata may be present between the Central Polish Massif and Kolobrzeg (Kolberg) on the shores of the Baltic Intensive research is now being conducted by the Polish Geological Institute and the Petroleum Research Company.

Parliamentary Topics

Rubber Agreement. — Misunderstandings which occurred at the recently concluded Geneva negotiations on rubber consumption substantially negatived the effect of the U.S. Government's agreement to reduce the compulsory use of synthetic rubber by U.S. manufacturers from one-third to one-quarter. This, recorded the President of the Board of Trade in a written answer, had been agreed in return for certain concessions in Colonial preferences enjoyed by the U.K. The text of the arrangement, as published, mentioned "one-quarter *including reclaimed rubber*," which in practice merely preserved a *status quo*. Mr. Harold Wilson admitted that the negotiators had made a mistake, but said that the U.S. Government had now signified its willingness to suspend the arrangement pending further negotiation.

Fertilisers for Africa.—East and Central African territories have asked for the following allocations of nitrogenous fertilisers:—Kenya, 825 tons of sulphate of ammonia and 25 tons of nitrate of ammonia; Tanganyika, 585 tons of sulphate of ammonia; Uganda, 960 tons of nitrogen; Zanzibar, none; Nyasaland, 2500 tons of sulphate of ammonia and 60 tons of nitrate of soda. These allocations are exclusive of the requirements of groundnut schemes.—Mr. Rees Williams.

Portland Cement—Exports and Imports.—Exports of Portland cement during the first ten months of the current year represented 0.3 per cent of the value of total U.K. exports, and the average price charged per ton was £3.7. Imports came from Belgium and Eire, the average c.i.f. value being £6.3 per ton.—Mr. J. Belcher.

Whaling Restrictions to Continue.—The Government does not feel that the existing international agreement to restrict the killing of whales is in need of review. Despite the present shortage of fats and oils, scientists have advised that the present limits cannot be relaxed without permanently endangering supplies of whale oil.—Mr. T. Williams.

Typewriters.—4329 typewriters representing a total value of £109,000 and 9.6 per cent of British output have been purchased by Government departments during the past 12 months.—Mr. Glenvil Hall.

Linseed Imports.—By the end of the 12-month period ending December 31 about 112,200 tons of linseed oil and 42,900 tons of linseed will have been imported.—Mr. J. Strachey.

Lime Production.—There are no deliberate restrictions in the output of lime, and production is as high as available supplies of fuel and labour permit.—Mr. C. W. Key.

Stanlow Project Started

Priority Licences Granted

IT was announced last week that work on the construction of a £750,000 oil refinery at Stanlow, near Ellesmere Port, has been started by the Wakefield Oil Company, Government priority licences having been granted. It will have an output of several thousand tons of lubricants a week, a major proportion of which will go to foreign markets. Fifty-two per cent of the production of motor oils and industrial lubricants will be for foreign consumption. Production should begin in June and be running at full scale before the end of the year.

LABOUR LIMITS SEAWEED PLAN

ALGINATE Industries, Ltd., is expected to remove one of its West Highland seaweed processing plants from Melfort to Eire. The Barcaldine and South Uist plants are to continue in operation. Lack of labour in the west coast area of Scotland has dictated this move. Any contemplated large-scale development of seaweed processing, now the subject of active research by the Scottish Seaweed Research Association, will meet this same problem, the vast bulk of Scottish seaweed being in areas where labour is limited.

Gamma Rays for Industry

Of interest to manufacturers and industrialists is an announcement that Gamma Rays, Ltd., of Smethwick can supply and advise upon the latest methods of non-destructive examination for the location and identification of all types of internal flaws in all metals and metal structures. This is achieved by application of the gamma ray, which has already been used successfully for the purpose in the U.K.

Gamma rays, which are described as complementary to—rather than competitive with—X-rays, are of evident value to designers and manufacturers of chemical plant and heavy engineering applications where castings and welding must be 100 per cent sound.

Steady Level of Chemists' Sales.—"The remarkable stability in the sales of independent chemists was again evident in the returns for October," records a current Board of Trade Review of retail trade in October. Compared with a year ago, the increase was 11 per cent, the same as the rise between the two years for the nine-months period February-October. Sales in the chemists' wares departments of the large-scale retailers were higher by 15 per cent in October and by 13 per cent in the period February-October than in the corresponding periods last year.

Home News Items

Science and the Law.—Dr. G. Roche Lynch, president of the Royal Institute of Chemistry, spoke on "Medico-Legal Experiences" at a recent joint meeting of chemical societies in the New Chemistry Buildings, Glasgow University.

Export Coal Price Up.—An average increase of 25s. per ton in the prices of coal for export and for bunkering foreign shipping at U.K. ports has been announced by the National Coal Board. Export coal prices took effect from December 1 last, and bunkering charges will operate as from January 1, 1948.

Long-range Greetings.—Passengers and crews on ships at sea can receive greetings telegrams at Christmas and the New Year, announces the G.P.O. Season's greetings should be sent in time for the New Year and messages will be held in the ship's radio office for delivery on the appointed date. All telephone services to the Continent were open as usual over the Christmas holidays.

Ironworks Explosions.—A series of five explosions occurred on Wednesday night last week at the Govan Ironworks, Glasgow, of William Dixon, Ltd., when a section at the bottom of a blast furnace collapsed. An official at the works stated that the explosions had been caused by liquid metal from the furnace meeting water when it ran into a large trough. The purpose of the trough was to catch the metal in the event of such a mishap.

New Record for Steel.—The steel industry in November broke another record, as it did in each of the preceding months. Steel ingots and castings in November were turned out at a weekly average rate of 272,600 tons, equivalent to an average rate of 14,174,000 tons, the highest scale ever recorded in the month of November. The annual rate of pig iron production during the month was 8,617,000, and the weekly rate was 165,900 tons—more than 5000 tons higher than the October rate.

Catchment Area Polluted.—The persistence of water-polluting materials has been evidenced by the sequel to complaints that the water in the district of Cwm Marian, Dyserth, tasted of petrol. The Council's surveyor last week gave the explanation that when an aircraft crashed on Cwm Mountain on December 5, the contents of one of the petrol tanks was spread over the collecting ground for the water supply of that area. The spirit percolated through the ground and found its way into the storage tanks and pipes leading to about 20 houses. That source of supply has now been isolated.

Bishop at Liverpool Factory.—The Bishop of Liverpool (Dr. Clifford Martin) recently made a tour of the modern factories at Speke. At Evans Medical Supplies, where he was welcomed by Mr. C. E. J. Sendall, director, he gave a short address to 700 employees.

1947-48 F.B.I. Register.—The F.B.I. Register for 1947-48, which has just been delivered from the printers, is already unobtainable for the home market, so phenomenal has been the demand, and no further orders can be accepted. Planned specifically to stimulate export business for F.B.I. members, the greater part of the 10,000 copies available have been despatched overseas.

Coal Prices to be Raised.—Prices of all qualities of deep-mined and outcrop coal (excluding slurry) are to be raised by 2s. 6d. per ton as from January 1, 1948. These increases will be reflected in the prices of all kinds of manufactured fuel, including coal gas, and are a direct consequence of the recent agreement between the National Coal Board and the National Union of Mineworkers on wage increases and overtime rates.

High-temperature Alloy Applications.—A course of six lectures entitled "Modern Applications of High-temperature Alloys" is to be given at the Sir John Cass Technical Institute, Jewry Street, E.C.3, on Thursday evenings at 6.15 p.m. commencing January 22, 1948. The lecturer will be Mr. C. G. Conway. The fee for the course will be 10s., and application for enrolment should be made to the Principal, Dr. A. M. Ward.

Linseed Oil Explosion.—A tank containing 500 gallons of linseed oil, overheated spontaneously at the oil refineries of Samuel Banner and Co., Sandhills, Liverpool, on December 12. Overheating had caused the oil to solidify and catch fire. Later the tank buckled, and blew off the asbestos roof of the brick building in which it was housed. Nearly two hours after the explosion, firemen were still pouring water on the tank as a precaution against a further explosion.

Mechanical Handling Exhibition.—With the approval of the Government and the support of leading associations in the industry, a new exhibition—the first National Mechanical Handling Exhibition and Convention—is to be held at Olympia, London, from July 12 to 21, 1948. It will be designed to show how mechanical handling can save labour and speed production, assembly, storage and transport in every type of industry. The journal *Mechanical Handling* are the promoters and six trade associations are to support the project.

Technical Reports on German Industry

REPORTS on German and Japanese Industry, now obtainable from H.M. Stationery Office at the prices indicated, include the following of interest to our readers.

BIOS 714. The development of new insecticides (6s.).

BIOS 1356. Grinding and treatment of minerals (9s.).

BIOS 1443. The German nitrogenous fertiliser industry (excluding cyanamide) in the Western zones (17s. 6d.).

BIOS 1539. German chlorate industry (3s.).

BIOS 1559. Starch and starch adhesives industry in Western Germany (3s. 6d.).

BIOS 1575. Carbonyl nickel and carbonyl iron powders, their production and properties (Interrogation of Dr. Leo Schlecht) (3s. 6d.).

BIOS 1576. Manufacture of saccharin and its intermediates at I.G. Farben factories (2s.).

BIOS 1590. Report of investigation at Stahlwerke, Kabel C. Pouplier, Jnr., at Hagen-Kabel. Manufacture of hardened, tempered, formed, polished and blowed, and cut to lengths, steel strip (1s. 3d.).

BIOS 1602. Manufacture and applications of vinyl alkyl ethers, acrylates, their polymers and co-polymers (9s. 6d.).

BIOS 1605. I.G. Farbenindustrie. The manufacture of intermediates and "Colour Formers" for Agfa Farbenfilm (3s. 6d.)

FIAT 874. The manufacture of ethylene oxide via chlorohydrination of ethylene (5s.).

FIAT 1080. The lower vinyl ethers and their use for acetaldehyde manufacture (2s. 6d.).

FIAT 1102. Polymerisation of vinyl acetate (5s.).

FIAT 1186. Acetylene carbon blacks (2s.).

BIOS MISC. 43. Information on manufacture of oil seal rings (simmer rings) (6d.).

BIOS MISC. 44. Experimental diesel engine at Motorenwerke, Mannheim (1s.)

BIOS 394. Technical report on the Ruhr Coalfield, Volume III, Appendix 16. Economic comparisons between the various types of underground locomotives (1s.).

BIOS 1445. Brown coal dust: Preparation, handling and utilisation (21s. 10d.).

BIOS 1591. German gas appliance industryy (3s.).

FIAT 732. Electrochemical operations at I.G. Farbenindustrie A.G., Bitterfeld (11s. 3d.).

BIOS 394. Technical report on the Ruhr Coalfield. Volume III, Appendix 27. Utilisation of low grade fuels in steam generating plants (9d.).

This report has been published separately by His Majesty's Stationery Office as a Ministry of Fuel and Power publication and should be ordered by title.

BIOS 1052. German acetylene chemical industry. Acetic acid (4s. 6d.).

BIOS 1147. *p*-Nitroaniline and related compounds: Development of continuous amination processes at I.G. Farbenindustrie, Hoechst (3s.).

BIOS 1477. Fish oil refining with some reference to marine animal oils (5s.).

BIOS 1577. The new potassium permanganate plant at I.G. Farben, Bitterfeld (1s.).

BIOS 1588. Nitrocellulose and cellulose acetate lacquers and ancillary materials (interrogation of Dr. Alfred Kraus (2s.).

BIOS 1598. Index of the major pest control products in the British, U.S. and French zones of Germany (3s. 6d.).

BIOS 1624. Manufacture of dioxan. The cyclic ether of diethylene glycol (1s.).

BIOS 1625. Manufacture of polyethylene oxide wax (1s.).

FIAT 872. The I.G. Hoechst glycerogen process (5s.).

FIAT 1148. The use of heat resisting steels in the manufacture of gas turbine blades in Germany (2s. 6d.).

BIOS 1122. Avoidance of toxic hazards in some German chemical factories (6s. 6d.).

BIOS 1153. I.G. Farbenindustrie: The manufacture of miscellaneous dyestuffs intermediates (excluding naphthalene derivatives (32s. 6d.).

BIOS 1423. The application of aluminium and its alloys in Germany (5s. 6d.).

BIOS 1467. German methods of production and aluminium coated and continuous electroplates steel strip (3s.).

BIOS 1557. The manufacture of technical phosphates in Western Germany (9s.).

BIOS 1562. German laboratory instruments industry (11s.).

FIAT 617. (Supplement No. 1. The electrical and technical ceramic industry of Germany. (Supplementary Reports) High dielectric constant insulators (2s.).

FIAT 653. Cuprammonium process synthetic rayon in Germany (3s.).

FIAT 968. Alcohols by hydration of olefins (3s. 6d.).

FIAT 1012. Screening device of slurries of organic chemicals (1s.).

FIAT 1039. Manufacture of isododecylphenol by I.G. Farbenindustrie A.G., Uerdingen (1s. 6d.).

FIAT 1077. The manufacture of phenol formaldehyde resins and moulding powders (6s. 6d.).

FIAT 1081. Manufacture of diethylamine for acetaldehyde. I.G. Farbenindustrie A.G., Ludwigshafen (2s.).

FIAT 1110. The production and use of polyvinyl alcohol (1s. 6d.).

PERSONAL

MR. V. ST. JOHN KILLERY, who has been appointed a director of Imperial Chemical Industries, Ltd., at 47, has been chairman of I.C.I.'s General Chemicals Division since 1945. He joined the company 24 years ago and has spent seven years in China for I.C.I.

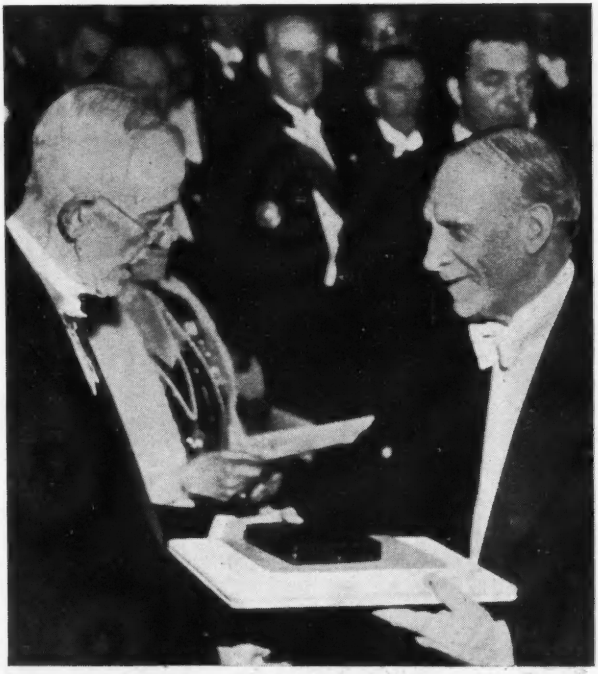
MR. CHRISTOPHER LEONARD GALE FAIRFIELD has joined the Mullard Wireless Service Co., Ltd., and will be principally concerned with promoting the application of Mullard research and development work to industrial problems. He holds a number of engineering and academic degrees and has had extensive experience with Balfour Beattie, Ltd., the Midland Counties Electricity Supply Company, Metropolitan-Vickers and the Central Electricity Board.

LORD LEVERHULME, under the name of William Thornton, has written many of the lyrics, set to music by a local school teacher, in the pantomime, "Cinderella," for the Port Sunlight Players, which he has written in collaboration with MISS SOPHIE SOMERS, a former departmental head at Port Sunlight. A cast of 100 amateurs will present the show in the week beginning December 29. As the Demon King, LEON WEAVER, who produces Port Sunlight's B.B.C. shows, will recite Lord Leverhulme's ode on the modern business man.

SIR EDWARD APPLETON was last week awarded the Charles Chree Medal and Prize for 1947. After the presentation Sir Edward gave an address, "Geomagnetism and the Ionosphere."

Obituary

MR. BENJAMIN TALBOT, who played an important rôle in the development of the continuous open-hearth process of steel manufacture, has died at Northallerton at the age of 83. Having become interested in the basic open-hearth process in this country, he went to the U.S. in 1890 to manufacture steel, and it was there that he first originated the method of removing the silicon in a preliminary continuous basic-lined refining furnace. Upon his return to England in 1900, his process was adopted by the Cargo Fleet and the South Durham Steel and Iron Companies. Among rewards he received were the Elliott Cresson and John Scott medals of the Franklin Institute of Philadelphia, and the Bessemer medal of the Iron and Steel Institute of the U.K.



Sir Robert Robinson receiving the 1947 Nobel Prize for Chemistry from King Gustav of Sweden. The award was presented to Sir Robert at the Concert Hall, Stockholm. Also honoured at the same ceremony was Sir Edward Appleton who received the Nobel Prize for Physics

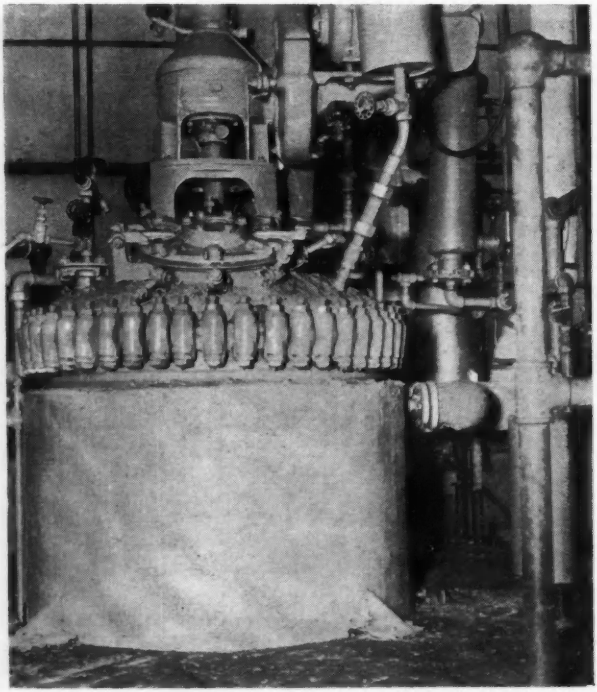
Overseas News Items

Mozambique Coal Discovery.—A recent survey at Tete, Mozambique, Portuguese East Africa, is stated to have revealed the existence of about 400 million tons of coal suitable for metallurgical coke. Within a year or so, an annual production of 500,000 tons is expected. Gold, copper, and iron-ore deposits have also been reported in the same locality.

Italian Reorganisation.—The Instituto di Recherche chimiche Montecatini, at Novara, has now been completely re-organised and is working on a full programme in its various departments. Another laboratory for agricultural research has been established at Signa, and new products already introduced, such as the anticryptogamic "M" which effectively replaces copper sulphate, the insecticide Cuprarsen, based—as its names implies—on copper arsenate; the A.L.M. fungicide; the DDT insecticide Gesarol made from a Geigy (Basle) patented formula.

Rich Rhodesian Iron Deposits.—Iron-ore deposits now being surveyed in Northern Rhodesia by British industrialists are proving to be both high-grade and extensive. At Lusaka, deposits assaying 65 per cent of ore are easily recoverable. It is proposed to work this field and another at Broken Hill with hydro-electric power from a scheme on the Kafue river.

Polish Chemical Output.—Output figures of the Polish chemical industry in August are (in tons) as follows: Tar products 17,326; benzol products 2899; carbon electrodes 444; explosives 1014; organic dyestuffs 161; oil paints and varnishes 211; zinc blende 736; ultramarine 63; pure acetic acid 41; nitrate fertilisers 10,174; superphosphates 20,715; hydrochloric acid 284; sulphuric acid 4799; ammonia 467; acetylene 2210; ammoniacal soda 6928; caustic soda 2868; soap 660; rubber footwear 156; tyres and tubes 302; emery wheels 29.



NEW GASKET MATERIAL

G-E silicone rubber gaskets that do not adhere to metal, and withstand temperatures up to 400°F. and maintain their original characteristics under high vacuum are now being incorporated in chemical reactors used in the manufacture of Glyptal alkyd resins by the (American) General Electric Co. One such reactor showing the silicone rubber treatment is pictured here. Providing excellent resistance to alcohol, phenol, aromatic hydrocarbons and other solvents, the material is said to be particularly effective as a gasket in the absence of a plasticiser in the silicone rubber stock. Practical tests lasting several months have proved that the gasket does not harden or crack under very exacting conditions

TECHNICAL PUBLICATIONS

"CHEMISTRY is a noble science and becomes useful in many sorts of business as well as a lasting source of amusement," wrote the Quaker Robert Howard to his 15-year-old son Luke, learning the rudiments of chemistry and much else as apprentice to a pharmaceutical chemist in Stockport. That recommendation now seems to have understated the prospect, in the light of the boy's subsequent achievement, which contributed much to ennoble the science by widening its scope and utility in this country and afforded his successors opportunities for profitable service upon which the present impressive chemical organisation of Howards & Sons, Ltd., was founded.

The romantic story of this growth, like that of the proverbial mustard seed, and embellished with echoes of contemporary events— such as the manufacture of fireworks to celebrate the victory of Trafalgar —is now told in "Howards: 1797-1947" with which the firm has effectively commemorated 150 years of its history. Apart from the almost unparalleled continuity in the family direction and pioneering spirit, characteristics of the story now brought to light are the spirit of comradeship which enabled workmen to give service which entitled them later to become partners. "The little group of eleven men, with which our founder started, has now grown to 700 employees," the chronicler records, "but it is our constant endeavour to continue to preserve the day-to-day contact with our workpeople which the records show was the practice of Luke Howard and his immediate successors, and which, if proportionately more difficult now, is in our view as essential to the wellbeing of a business to-day as in the simpler times of 150 years ago."

* * *

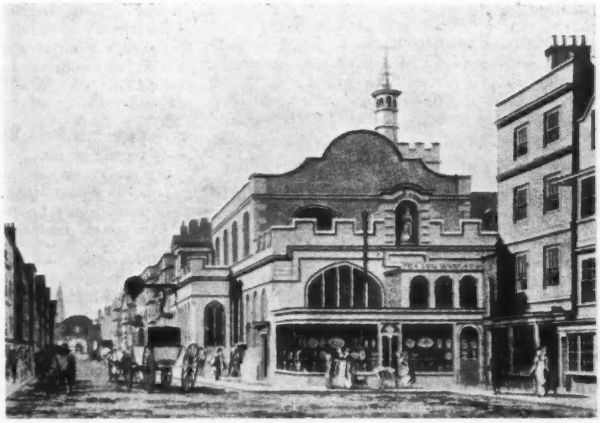
The list of British Standards for the chemical industry just issued by the British Standards Institution, "Chemicals, Fats, Oils, and Scientific Apparatus," provides a guide to all relevant standards obtainable from the Institution (2s. each). Among the ten sub-sections, which include Coal derivatives, Glues and Gelatines, Petroleum Derivatives, and Solvents, is one for Scientific Apparatus, containing no less than 38 standard specifications, by far the largest of the group.

* * *

A pamphlet that will be of interest to those concerned with the manufacture and repair of plant and equipment required by the chemical industry, is "Metal Powders for Welding Electrode Manufacture," issued by Murex, Ltd., Rainham, Essex. It contains a list of 30 metal powders of various grades and mesh, together with notes on their use and composition.

* * *

The extraordinary versatility of paraffin wax is the subject of an informative and well illustrated leading article in the Christmas number of "Naft Magazine," the Anglo Iranian Oil Company's journal. Another principal feature of the current number, which represents better than almost any other how technical subjects can be presented to non-technicians in highly palatable form is the study by Sir Frank Smith, "What is Petroleum," providing a short and simplified study of the chemistry of hydrocarbons.



This was Fleet Street, east of Temple Bar in 1795, when Luke Howard, first of the line of distinguished chemists, set up his shop opposite St. Dunstan's Church—which stands behind the clock. Two years later he started, in partnership with William Allen, the manufacture of chemicals, which his descendants have so fruitfully developed

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for errors that may occur.

Mortgages and Charges

(Note.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every company shall, in making its Annual Summary, specify the total amount of debt due from the company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an °—followed by the date of the Summary, but such total may have been reduced.)

STERLING METAL & MACHINERY CO., LTD., London, E. (M., 27/12/47.) November 24, £300 debenture. to M. H. Thorp, London, and another; general charge. *Nil. November 10, 1938.

BRITISH EMULSIFIERS, LTD., London, W. (M., 27/12/47.) November 21, £8000 (not ex.) mortgage, to Lloyds Bank, Ltd.; charged on freehold property on east side of Edison Road, Crouch End. *Nil. January 28, 1947.

New Companies Registered

Gaye Products, Ltd. (445,924).—Private company. Capital £100. Manufacturers of chemicals, gases, drugs, medicines, etc. Directors: A. E. Barnett and Mrs. Z. Barnett. Reg. office: 140 Piccadilly, W.1.

Broadbent and Taylor, Ltd. (446,266).—Private company. Capital £1000. Coppersmiths and smelters, copper sulphate manufacturers, copper tube makers, founders, etc. Directors: C. H. Taylor, and G. J. Broadbent. Reg. office: 10 St. Mary's Row, Birmingham, 4.

Uxbridge Pharmaceutical & General Supplies, Ltd. (446,023).—Private company. Capital £1000. Directors: W. F. C. Mead and Mrs. W. F. Mead. Reg. office: 28 New Broadway, Uxbridge Road, Hillingdon, Middlesex.

Syn-Gel, Ltd. (446,129).—Private company. Capital £100. Wholesale and retail manufacturing and research chemists, druggists, drysalters, oil and colour men, etc. Secretary: J. P. Moll. Reg. office: 8 Draper's Gardens, E.C.2.

Peter Leslie & Co., Ltd. (446,116).—Private company. Capital £1000. Wholesale and retail chemists and druggists, chemists' sundriesmen, etc. Subscribers: L. J. Gliksten and K. Wexler. L. J. Gliksten is the first director. Reg. office: 1 Maychurch Close, Stanmore, Middlesex.

Stockdale Engineering, Ltd. (446,019).—Private company. Capital £2000. Chemical, mechanical, heating, ventilating, light, electric, hydraulic, structural and general engineers, etc. Directors: W. Stockdale and Mrs. M. V. Stockdale. Reg. office: Royal London House, 196 Deansgate, Manchester.

Tenz (Ireland), Ltd. (12,147).—Private company. Capital £1000. General merchants, manufacturers, importers and exporters of and dealers in chemical drugs and other medicinal preparations. Subscribers: J. D. Kiernan, 117 Upper Leeson Street, Dublin, and V. Dillon.

Silexine Colours and Chemicals, Ltd. (445,373).—Private company. Capital £100. Dealers in all kinds of mineral, vegetable or chemical substances; research workers, etc. Directors: R. B. E. Jackson, C. F. Krabbe, and Mrs. Eva Armitage. Registered office: 93 Goldhawk Road, W.6.

Trans-Chemicals, Ltd. (445,735).—Private company. Capital £50,000. Wholesale and retail dealers in and distributors, importers and exporters of fine and heavy chemicals, intermediates, pharmaceuticals, dyes, pigments, plastics, mineral oil and products, fertilisers, insecticides, etc. Solicitors: Parker, Garrett and Co., E.C.3.

Industrial Raw Materials Corporation, Ltd. (445,883). — Private company. Capital £10,000. Dealers in oils, waxes, chemicals, drugs, dyestuffs, paints, materials and products, general merchants, agents, brokers, etc. Directors: A. Aufhauser, P. G. Simonis, and J. W. Dryburgh. Reg. office: Burley House, 5-11 Theobalds Road, W.C.1.

J. K. Innes & Co., Ltd. (446,225).—Private company. Capital £6000. Chemical and drying engineers, designers and manufacturers of and dealers in chemical and drying plant, special purpose equipment, etc. Directors: J. K. Innes, W. J. Raven and J. W. W. Trench. Secretary: Irene Innes. Reg. office: 4 Laws Lane, Carlisle.

New B.P. Every Five Years.—The General Medical Council has approved the recommendation of the British Pharmacopoeia Committee that the British Pharmacopoeia shall be re-published at intervals of five years, instead of ten years.

U.S.A. "Stockpiles."—The U.S. authorities are reported to be increasing their stockpiles of imported chemical products. The principal items of which stocks are said to have been accumulated include Chinese tung oil, rapeseed oil, palm oil, shellac and linseed oil.

Chemical and Allied Stocks and Shares

ACTIVE dealings in home rails and further reinvestments in leading industrial shares have given stock markets a firm and active appearance at the close of the year. Moreover, the coal production news had a good influence on sentiment, although on the other hand, the higher price of coal, the raising of the price of tin and the forecasts of further increase in prices of commodities and materials in the early part of the new year have emphasised the inflation menace. Granted the British Transport stock terms are in accordance with anticipations (the official announcement is due on January 2) the prevailing tendency is to expect active and buoyant markets until the April Budget, when steps will, in any case, have to be taken to lessen the inflation danger If the export drive has not then shaped satisfactorily, further austerities at home will be the logical outcome.

Meanwhile, British Funds are strengthening on revived talk of the possibility of official support for the market before the end of the year. Industrials are favoured on the assumption that in most cases there are reasonable prospects of dividends being maintained, and that in some instances scope for higher payments seems good, because, despite the doubled Profits Tax, various companies will benefit materially from the end of E.P.T., provided, of course, that trading profits are maintained.

In accordance with the general trend, shares of chemical and kindred companies are closing the year actively and tending to continue the upward movement which developed recently. In most cases, however, current prices are below best levels touched in 1947, but they are well above the year's lowest. Imperial Chemical, for instance, are 52s. 3d., compared with 1947 extremes of 53s., and 40s. 9d., recent buying being attracted by the company's big stake both in home and export trade, and by the view that in due course the annual distribution may very well exceed last year's 10 per cent. Fisons, helped by the success of the preference issue by British Chemicals and Biologicals, were active around 71s. and are closing the year at their highest during the past twelve months

British Glues & Chemicals 4s. ordinary at 23s. have risen in anticipation of the interim dividend next month, and are nearly up to their best for the year, extremes being 23s. 9d. and 15s. 9d. On the other hand, following the 125 per cent dividend, Glaxo Laboratories 10s. units encountered profit-taking and came back from £23½ to £21¼. In this case the year's highest and lowest were £33 and £13 respectively. Among paint shares Lewis Berger have been firm at £9½, following the annual meeting and the chairman's reference to the patented use of "Styrene" in the production of paint. Fluctuations in the shares in 1947 have been between £5⅞ and £9 11/16. The units of the Distillers Co. have been firm at 31s., and since being subdivided into their present form of 4s. shares have become a more active market.

Yield considerations continued to attract attention to iron and steel shares, with United Steel prominent and Dorman Long active, the publication of the latter company's "1947 Illustrated" having drawn attention to its diversified activities and the big Tees-side project. Oil shares received an impetus from further statistics showing the rapid expansion in world consumption of oil. Shell, however, eased to 73s. 9d. with the new shares 13s. 9d. premium, but Apex at 47s. responded to the dividend and Ultramar advanced to 75s. on expectations of the production stage being reached in 1948.

British Chemical Prices

Market Reports

STEADY conditions have been maintained in the chemical markets and while no important price changes have been reported. values are very firm and an upward trend in the New Year is regarded in some quarters as a real possibility. There has been a certain amount of contract replacement, but producers are hesitant to enter into long-term commitments. Reports indicate that export trade has been fully maintained and in the coal-tar products section the volume of overseas inquiries has been on a good scale, with pitch and naphthalene commanding higher rates.

GLASGOW.—In the Scottish chemical market, normal conditions have prevailed during the past week, apart from the certain amount of stocking up of materials obtained from English work which will be closing for the Christmas holiday. The demand for solvents has increased although available supplies have not. In the export market, there have been signs that more settled conditions with regard to import licences and credit are beginning to prevail in Greece.

French Fertiliser for U.S.A.—A cargo of muriate of potash from France was landed in the United States early in December. This first shipment of about 5000 tons is to be followed by further deliveries of about 240,000 tons in the 1947-48 season. Last season, a total of about 290,000 tons was shipped.

Patent Processes in Chemical Industry

The following information is prepared from the Official Patents Journal. Printed copies of specifications accepted may be obtained from the Patent Office, Southampton Buildings, London, W.C.2., at 1s. each.

Complete Specifications Open to Public Inspection

Brightening of aluminium and aluminium alloy articles having oxide coatings thereon.—Aluminium Co. of America. April 12, 1946. 8431/1947.

Preparation of piperazine mono carboxamides.—American Cyanamid Co. April 12, 1946. 8956/1947.

Process and apparatus in the production of aluminium and other powder with leaf structure or needle form.—Carlfors A/B and K. G. Winquist. Jan 11, 1946. 26487/1947.

Manufacture of disazo-dyestuffs.—Ciba Ltd. April 11, 1946. 7687-88/1947.

Manufacture of polyazo-dyestuffs.—Ciba Ltd. April 11, 1946. 7689-90/1947.

Methods of hydrolysing fat and apparatus for carrying out said methods.—Emery Industries Inc. March 13, 1946. 25811/1947.

Process for preparing complex organic compounds of antimony.—E. A. H. Friedheim. April 9, 1946. 9330-31/1947.

Production of interpolymers.—B. F. Goodrich Co. April 10, 1946. 8781-82/1947.

Treatment of hydrocarbons.—Lummus Co. Nov. 13, 1943. 24952-54/1947.

Preparation of β-carboxymethylmercapto analine.—Merck & Co., Inc. March 14, 1946. 4964/1947.

Purification of synthetic alcohols.—Montecatini Societa Generale Per L'Industria Mineraria e Chimica. June 17, 1944. 25276/1947.

Apparatus for separating liquids.—N.V. De Bataafsche Petroleum Maatschappij. April 9, 1946. 8333/1947.

Derivatives of 2-amino pyrimidine and its homologues and processes for producing the same.—Pyridium Corporation. April 8, 1946. 37042/1946.

Manufacture and use of germicidal compounds.—F. J. Sowa. May 16, 1942. 11907/1943.

Sulphuric acid concentration.—Standard Oil Development Co. April 11, 1946. 19753/1947.

Synthetic resins.—Westinghouse Electric International Co. March 27, 1946. 1254/1947.

Control systems.—Westinghouse Electric International Co. June 14, 1944. 19587-88/1947.

Method for producing a basic quinoline compound.—T. A. Williamson. April 8, 1946. 8274/1947.

Reclaiming copolymers.—Wingfoot Corporation. April 13, 1946. 24411/1946.

Refining of crude olefinic nitriles.—American Cyanamid Co. Oct. 31, 1939. 18261/1945.

Method of producing shaped bodies from powdery aluminium.—American Electro Metal Corporation. April 16, 1946. 9150/1947.

Dyeing methods.—American Viscose Corporation. April 16, 1946. 8946/1947.

General method and means for treating oils of any origin, chiefly naphtha-containing oils, schist oil, lignite oil, etc.—D. Balachowsky and Soc. Des Moteurs et Automobiles Lorraine. April 16, 1946. 10071/1947.

Method for baking ceramic products.—L. Bernardaud et Cie. April 17, 1946. 17497/1947.

Cleansing process and the manufacture of cleansing preparations therefor.—Ciba Ltd. April 18, 1946. 9123-5/1947.

Manufacture of new polyazo-dyestuffs.—Ciba Ltd. April 16, 1946. 33045/1947.

Manufacture of crystalline mixed sulphates.—Communication Engineering Pty., Ltd. April 15, 1946. 7321/1947.

Methods of conditioning water for steam generation or for boiling.—Dearborn Chemical Co. April 22, 1940. 15404/1943.

High explosive composition.—E.I. Du Pont De Nemours & Co. July 9, 1943. 7355/1947.

Aqueous dispersions of polyvinyl chloride.—E.I. Du Pont De Nemours & Co. April 16, 1947. 10076/1947.

Purification of tetrachlorethylene.—E.I. Du Pont De Nemours & Co. April 17, 1946. 10077/1947.

Production of smooth electrodeposits.—E.I. Du Pont De Nemours & Co. April 17, 1946. 10365/1947.

Production of bleached ground wood pulp.—E.I. Du Pont De Nemours & Co. Feb. 21, 1946. 14422/1947.

Bleaching wood pulps.—E.I. Du Pont De Nemours & Co. March 30, 1946. 16244/1947.

Catalytic conversion of hydrocarbons.—M. W. Kellogg Co. May 21, 1941. 14044/1942.

Catalytic conversion of hydrocarbons.—M. W. Kellogg Co. April 24, 1941. 14045/1942.

Catalytic conversion of hydrocarbons.—M. V. Kellogg Co. Aug. 6, 1941. 14046/1942.

Catalytic conversion of hydrocarbons, etc.—M. V. Kellogg Co. July 31, 1941. 14047/1942.

Dehydrogenation of alkyl aromatic compounds.—Koppers Co., Inc. April 12, 1946. 27448/1946.

Manufacture of intermediates useful in the synthesis of Vitamin B_6.—Merck & Co., Inc. July 22, 1943. 14395/1944.

Chemical processes.—Merck & Co., Inc. April 16, 1946. 9227/1947.

Chemical processes.—Merck & Co., Inc. April 16, 1946. 9383/1947.

Synthesis of adrenal cortical hormone.—Merck & Co., Inc. July 14, 1945. 19046/1947.

Methods of making organic hydroxy esters, and the improved organic hydroxy esters resulting therefrom and the improved compounded lubricants including the improved organic hydroxy esters.—Monsanto Chemical Co. April 17, 1946. 3422-23/1947.

Production of aluminium fluoride in soluble form.—Montecatini Soc. Generale per L'Industria Mineraria e Chimica. April 29, 1944. 26924/1947.

Method of solubilising natural phosphates and producing mixed fertilisers.—Office National Industriel De L'Azote. April 8, 1946. 36109/1946.

Manufacture of dyestuffs of the copper phthalocyanine type.—G. M. O'Neal. Feb. 15, 1941. 26608/1947.

Polymeric detergents.—Rohm & Haas Co. Sept. 9, 1944. 3858/1945.

Production of sodium-penicillin.—E. R. Squibb & Sons. Aug. 6, 1943. 17988/1944.

Process for the refining of waxes.—Standard Oil Development Co. July 24, 1941. 26858/1947.

Surface active agents and process of making same.—Sun Chemical Corporation. Feb. 12, 1946. 13645/1947.

Nitriles and process of making same.—Sun Chemical Corporation. Feb. 12, 1946. 13646/1947.

Method of regenerating copolymers.—Wingfoot Corporation. April 13, 1946. 24410/1946.

Friction mechanism.—Wingfoot Corporation. April 16, 1946. 33096/1946.

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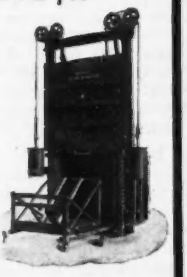

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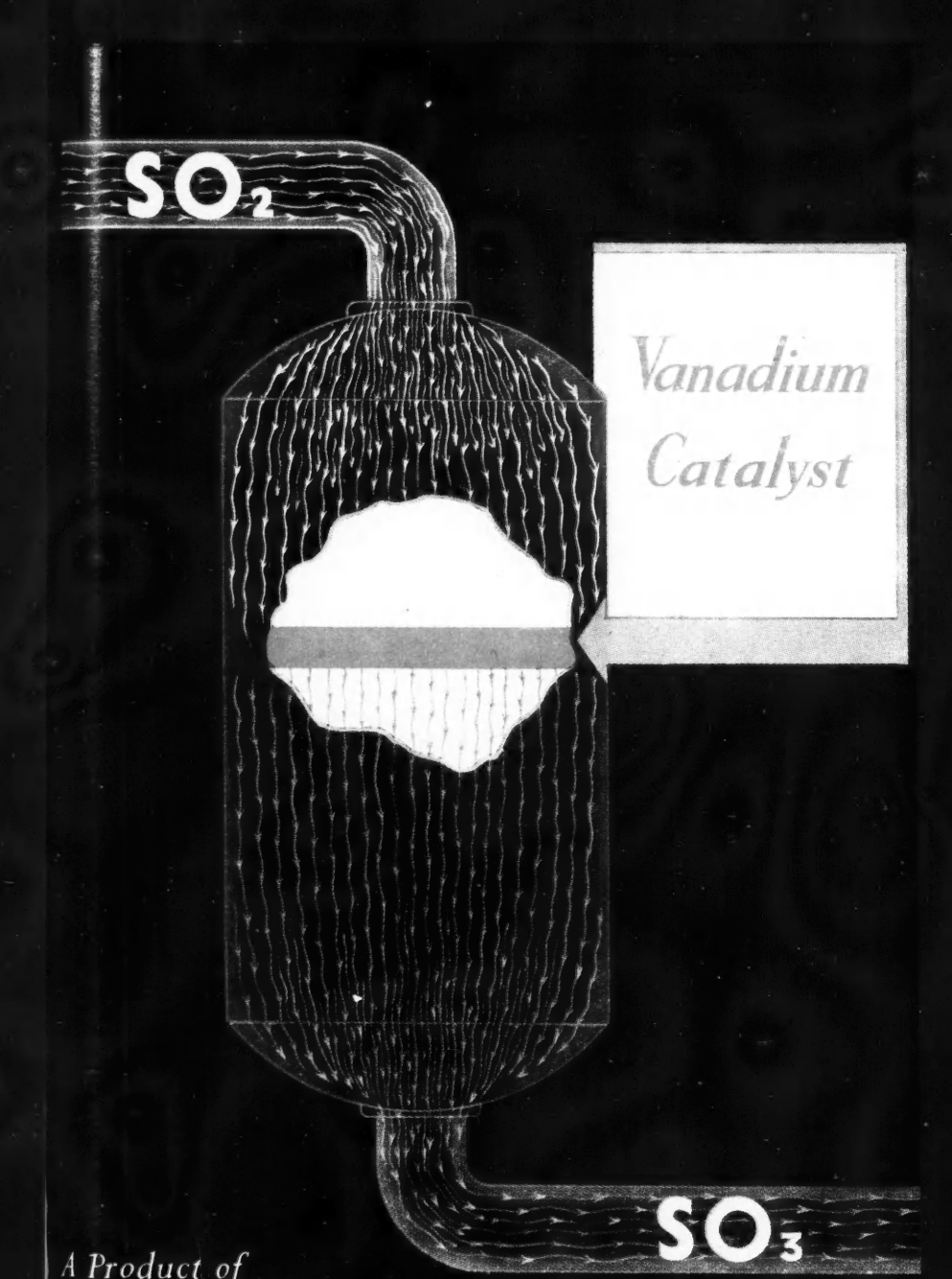

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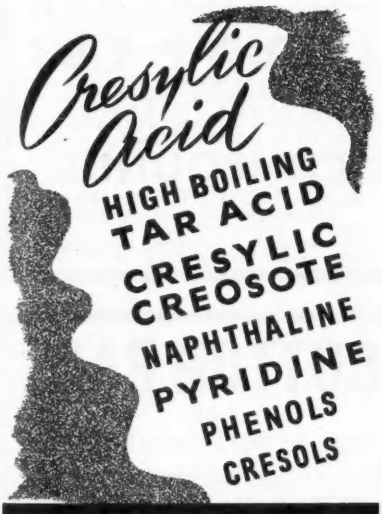

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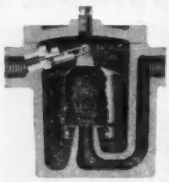

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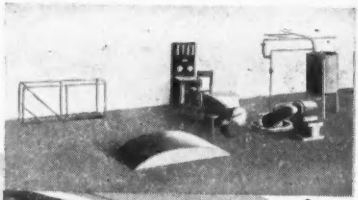

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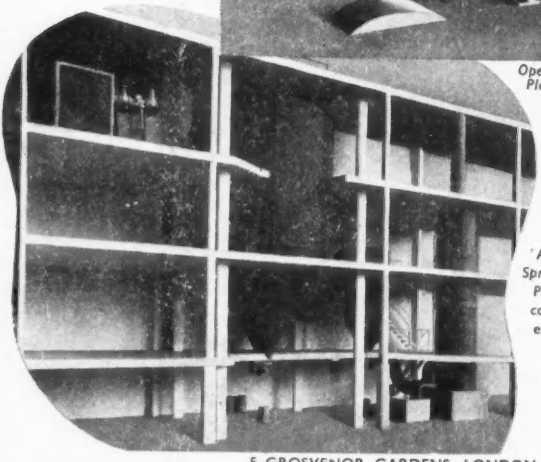

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Metallurgical Section

Published the first Saturday in the month

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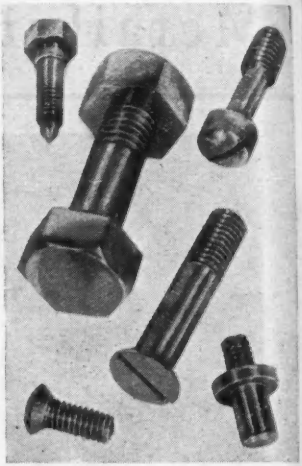

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Metallurgical Section

5 July 1947

PRECIPITATION HARDENING—IV*

by L. SANDERSON

WHEN duralumin has been subjected to mechanical working while in the cold condition it is advisable to anneal it afterwards so as to develop maximum stable ductility in the alloy. The best annealing treatment is to heat the alloy to a temperature of 350° C., hold at temperature long enough for the heat to penetrate right through to the centre of the piece, and cool in air. No ill effects will result from a protracted annealing temperature maintenance period.

For solution treatment, the alloy is heated to a temperature within the range 480° to 500° C. and maintained at this temperature for a period of about 60 min. Duralumin does not exhibit a sharp arrest point, as does steel, so that there is not the same reason for a drastic quenching operation. Oil quenching may, therefore, be safely employed, and is advisable because warping is thereby minimised.

Aging Treatment

The aging treatment depends on whether quick aging is required or whether time is less important. For normal aging, a period of 24 hours is sufficient to produce good results. Heating to a higher temperature will, however, age the material much more rapidly and develop the best possible properties. Duralumin being stable is not one of the alloys that age of their own accord.

When duralumin is artificially aged, it develops a greater elongation percentage, becomes more flexible, and is more adapted to cold working, while there is a higher resistance to corrosion. In addition, there is an appreciable increase in ultimate tensile strength. A point of interest is that duralumin develops oxide tints when heated in somewhat the same way as steel, and while the correspondence between these "temper colours" and the furnace temperatures is not so close as with steel, it is possible to form a rough comparison between them.

There is a method whereby duralumin after it has been quenched can be retained in a mild and ductile condition. This applies also to other alloys of aluminium. The advantage is that the quenched materials are then in a condition in which they can be kept in stock until their employment is necessary, instead of having to be put to use at once. The method consists of maintaining the material at a temperature below that of the atmosphere, which delays normal aging. Rivets and other parts have been water-quenched, washed in alcohol to obviate adhesion of the rivets or parts, and stored in paraffin at a temperature of about − 17° C., the temperature being held at this point by means of dry ice.

It is possible to cool the alloy at a regulated speed so as to inhibit ordinary precipitation of the constituents that produce a hardening effect, while not maintaining the soft solid solution typical of alloys subjected to swifter cooling, and this is said to develop effects comparable to those of aging, without any other effect on the material.

Alloying with Manganese

A development in the use of the aluminium alloys is the employment of alloys containing magnesium and silicon with a base of aluminium for electrical conduction. Such alloys have a typical composition of 0.55 per cent silicon, 0.6 per cent magnesium, 0.4 per cent manganese, 0.3 per cent iron, the balance being aluminium. These have a conductivity about four-fifths that of pure aluminimum. The inclusion of manganese in the composition has the effect of lowering the conductivity, but on the other hand it keeps the grain size small and minimises corrosion, so that its presence is on the whole advantageous.

The precipitation hardened magnesium alloys are rapidly establishing themselves as competitors of the aluminium alloys, and are employable in the form of die castings, sand castings, extruded parts, and forgings, but up to now they have not been used to any great extent in sheet form. The best known and most widely employed alloys of this type are the magnesium aluminium alloys, which contain about 10 per cent of aluminium. In these, the precipitation hardening constituent is Mg_2Al_2 and precipitation is not continuous. A typical composition for this group is 6 per cent aluminium, 0.3 per cent manganese, 3.0 per cent zinc, and a trace of silicon, the balance being magnesium. The ultimate tensile strength of the magnesium alloys ranges from 9 to 28 tons per sq. in., elongation from 11 to 1 per cent, according to the condition. Forgings that

* Previous articles appeared on February 1, April 5 and June 7.

have been solution-treated and aged have the highest tensile strength and an elongation range of from 5 to 1 per cent. Sand-cast magnesium alloys have a tensile strength of only 9 to 12 tons per sq. in. and an elongation range of 7 to 2 per cent.

Copper base alloys can be precipitation hardened, but from the industrial point of view the only ones that matter in this respect are the alloys of copper and beryllium, commonly termed beryllium bronzes, in whose composition is about 2½ per cent of beryllium, with the addition on occasion of percentages of cobalt and silver, introduced to minimise the beryllium content (and therefore the cost). The beryllium content must not exceed 2½ per cent or the alloy will be practically unworkable, while if the beryllium falls below 1 per cent precipitation hardening is not obtained.

These beryllium bronzes are sensitive to heat treatment, and can be given an ultimate tensile strength of about 42 tons per sq. in. by judicious heat treatment, while an alloy containing 1½ per cent beryllium after being aged and mechanically worked in the cold state has been found to have an ultimate tensile strength of about 85 tons per sq. in.

Alloys of this type are normally solution treated at 800°C., and in the aged state are capable of withstanding a good degree of heat and wear, while they are hard and tenacious. Their electrical conductivity is from a third to a half as high as that of copper.

Alloys of copper and silicon or copper and zinc are capable of being precipitation hardened to a slight extent.

Ternary Alloys

Hitherto the alloys of copper dealt with are of binary type. When we turn to the ternary alloys, it is found that there are various copper alloys capable of being precipitation hardened. Among these are copper-nickel-silicon, copper-nickel-aluminium, copper-silicon-manganese, copper-nickel-tin, copper-chromium-silver, and copper-nickel-phosphorus alloys. The alloying elements that have to be introduced into the composition of the alloys to render them capable of precipitation hardening are nickel, cobalt or silicon and aluminium. To make the material sensitive to this form of heat treatment, one or other of these alloying elements must be included.

The copper-nickel-silicon alloys are quenched from a temperature of 900°C., which gives them a hardness of about 60 V.P.N. After an aging treatment at about 400°C., they acquire a hardness of about 180 V.P.N. by reason of the precipitation of Ni_2Si. The copper-nickel-aluminium alloys are of some industrial importance, and for the best results it is essential that the proportion of nickel to aluminium should be about 4 to 1. There must be a minimum of 0.5 per cent aluminium present, but if the aluminium content exceeds 3 per cent difficulty will be experienced in cold working. The best results appear to be obtained with a composition of about 2 per cent aluminium, 8 per cent nickel and 90 per cent copper.

Precipitation hardening of these alloys is achieved by heating them to a temperature of about 900°C., quenching in water, and tempering at about 400° to 600°C. for a period of two hours. This causes the discontinuous precipitation of Ni_3Al, and NiAl (a point not absolutely certain), which produce the hardening effect.

Increasing Industrial Use

Alloys of copper-nickel-tin are of increasing value industrially, and for the best results should contain about 6 per cent tin and 6 per cent nickel, which will produce an alloy having an ultimate tensile strength of about 45 tons per sq. in., a yield point of about 37 tons per sq. in., a limit of proportionality of about 27 tons per sq. in., and an elongation of 10 per cent, with a Brinell hardness number of 200.

Alloys of copper-chromium-silver are usually heated to a temperature of about 1000°C., quenched, and tempered at 450°C. for a period ranging from 16 to 24 hr.; the result is a reasonably corrosion-resistant alloy capable of conducting heat and electricity.

The remaining ternary precipitation hardening copper alloys are of little industrial significance.

The precipitation hardening of iron and steel, commonly termed "aging," occurs spontaneously at room or slightly elevated temperatures when the steel has been given its concluding heat treatment, or has been subjected for the last time to mechanical working while in the cold state. At room temperature, aging of these materials is gradual, but the higher the temperature rises, the more rapid the aging. The effect of aging may be greater hardness and strength, a reduction in ductility and ability to resist impact, the recurrence of a well-defined yield point in the smooth stress-strain curve of slightly cold-worked steel, and corresponding modifications of other characteristics.

Aging in steel seems to exhibit three specific forms: (a) loss of toughness resulting from deformation within the blue heat range. This is usually known as blue brittleness; (b) a form known as strain aging, indicated by the modification of mechanical properties occurring when steel that has been plastically deformed at normal temperature or has been heated after plastic deformation to a fairly low temperature is stored; (c) a form known as quench aging, occurring when steel of low carbon

content, and dead mild, has been severely quenched and is stored at normal temperature.

The elements that can develop precipitation hardening in steel are carbon, oxygen and nitrogen. It is possible for silicon and phosphorus to produce precipitation hardening, but not in the percentages in which they are normally present in steel. Manganese and sulphur are of little significance from this point of view. Of the three principal hardening elements enumerated, oxygen appears to be ineffective in producing quench aging unless carbon and nitrogen are present, but does produce strain aging. In stating this it is assumed that the oxygen content of the steel is not excessive.

Little is understood as yet concerning the manner in which strain aging is produced, but it appears to be fairly well established that this form of aging is developed solely by oxygen, or at all events by its influence on the strain-aging produced by carbon and nitrogen. Quench aging, however, is unquestionably the result of carbide precipitation.

Within the temperature range at which blue brittleness occurs (100°-300°C.), aging does not occur at a rapid rate, and this is seen from the stress strain curve of mild steel within this range, which is irregular by reason of the swift changes in load during deformation. The reason for this is that plastic deformation takes place on a particular series of slip planes. The sharp yielding releases the support provided by the tensile testpiece. The load declines for a moment, after which aging, which must occur virtually at once, raises the resistance to additional slip on that particular series of slip planes. The load then increases to a greater value in advance of a further yield by a fresh series of slip planes. We thus obtain quick changes of load necessary to maintain the deformation, with an irregular stress-strain curve in consequence.

When steel is strained, a modification in properties may occur as a result of mechanical working while cold. Other changes that may be produced are precipitation or dispersion of another phase as a result of the plastic strain. This last is the true strain aging, and is normally measured as a variation in hardness or impact value taken in conjunction with time after hardening. The theory favoured at the moment is that plastic strain sets up local supersaturation along slip planes, followed by precipitation. It is, however, reasonable to believe that a little precipitation may arise during straining, and this is suggested by the fact that non-aging steels do not increase in hardness so rapidly as steels capable of aging.

Strain aging normally produces a smaller hardness increase than quench aging, but makes the steel more brittle. The steels most sensitive to strain aging are those of large grain size. Strain aging results in the re-establishment of the yield point elongation step to the smooth stress-strain curve for mild steel that has been subjected to mechanical working while cold. It is this that leads to the development of stretcher strains in deep-drawn steel, which can only be eliminated by immediate use of the temper-rolled sheet as soon as it comes from the mill. If this is done, there will be no time for the material to have its yield point re-established by aging. Alternatively, a non-aging steel can be employed.

The concluding section will deal mainly with the quench aging of steel and hardening in alloy steels.

Czechoslovakian Mining Industry

CZECHOSLOVAKIA'S output of coal, iron and steel is rising and may reach pre-war levels under the present two-year coal plan. The country's deep-mined coal in 1937 totalled 16.79 million tons and in 1946 had reached 14.15 million tons. It is estimated that this year the total will reach 16.27 million tons and brown coal (19.42 million tons) and lignite have already reached higher levels of production than before the war.

The rise in pig-iron and steel production in Czechoslovakia is a second important target in the two-year-plan. Pig-iron production amounted to 1.67 million tons in 1937 and reached only 961,000 tons in 1946. It is planned to bring the Czechoslovak pig-iron production to 1.34 million tons in the current year—about 40 per cent more than in the last year. Steel production diminished from 2.32 million tons in 1937 to 1.67 tons in 1946, and is expected to reach 2.2 million tons in the current year.

Malaya's Tin and Rubber

A memorandum circulated by Malayan Tin Dredging and Southern Malayan Tin Dredging, draws the attention of stockholders and M.P.s to the importance of the tin and rubber industries of Malaya not only to that country's economy, but because they are the greatest source of dollar exchange in the British Empire. The main subject of the circular seems to be the urgent necessity of rehabilitating the industries of the area. War losses in Southern Malaya are said to amount to £1¼ millions.

Oxygen for Carbon Reduction in Open Hearths

From Our New York Correspondent

A NEW method of using oxygen to speed the refining of steel in the open hearth and so increase tonnage output by 25 per cent was described by F. B. Lounsberry, vice-president of the Allegheny Ludlum Steel Corp., and G. V. Slottman, manager, of the Technical Sales Division, Air Reduction Sales Co., at a special panel discussion conducted by the American Iron and Steel Institute at the Hotel Pierre, New York, recently, in connection with the Institute's annual meeting.

Oxygen has always played a vital rôle in steelmaking because it combines with carbon and other elements in the molten metal during its refining in the open hearth. But the oxygen hitherto has been obtained from the air in the flame over the molten bath and considerable time elapsed before the oxygen penetrated the slag and metal. Furthermore, the concentration of the oxygen has been limited to that of its concentration in the air.

Introduction of Oxygen

Both Mr. Lounsberry and Mr. Slottman developed a method of introducing oxygen gas, rather than air, through a pipe below the surface of the molten metal. In this manner they delivered the concentrated gas directly and rapidly to a zone which normally receives little oxygen. The introduced oxygen first combines with molten iron to form ferrous oxide. This compound transfers the oxygen to the carbon and other elements which are to be removed from the molten iron, thereby aiding its refining into steel. After completing a series of open hearth experimental heats, it was found that the injecting of gaseous oxygen directly into the bath speeded the removal of the carbon so rapidly that 25 per cent more steel could be refined as against the conventional open hearth steelmaking practices. It was found that the decreased time of making the steel did not affect its quality.

The rate of oxygen supply to the bath varied from 27 lb. (330 cu. ft.) to 62 lb. (810 cu. ft.) per minute. The experimental heats were made in a 90-ton furnace at Allegheny Ludlum Steel Corporation's plant at Brackenridge, Pennsylvania. The furnace operated on all cold charges with baths melting at 0.3-0.6 per cent carbon. Refining was formerly done under highly oxidising slags to produce steels of 0.02-0.03 per cent carbon content. In the experimental heats the charges consisted of 85,000 lb. of basic pig iron, 93,000 lb. of Grade A open hearth rolled scrap, 22,000 lb. of silicon steel scrap, and 16,500 lb. of limestone. No ore was added either in the charge or during the heat, and the only addition made was small quantities of fluorspar. At the end of the lime boil, oxygen was added to the bath through a one-inch diameter pipe at various constant rates of flow. Analyses were made of the carbon, manganese, phosphorus and sulphur content of the bath at suitable intervals during the oxygen "blow" and corresponding slag samples were taken and analysed for FeO, Fe_2O_3, CaO, SiO_2, MnO, MgO, P_2O_5 and Al_2O_3. Additional heats were made using two pipes to supply oxygen simultaneously to the molten bath.

At another panel discussion, dealing with the problems of raw materials, Carl A. Ilgenfritz, vice-president, purchases, U.S. Steel Corp., Pittsburgh, Pennsylvania, reported on the world situation on coating materials. The position of the United States is critical in the three important coating metals, lead, zinc, and tin, according to Mr. Ilgenfritz, who offered a world-wide review of the economic aspects of these metals. Mr. Ilgenfritz pointed out that the steady decline of domestic lead output in the United States in recent years in the face of rising consumption has made the United States increasingly dependent upon imports, and accounts for the present extremely critical position of this metal. Since the entire lead output of Silesia and Jugoslavia now goes to Russia, the requirements of Western Europe have been shifted to Australia and the Western Hemisphere, resulting in sharply reduced lead shipments to the United States from Mexico, Canada, Peru, and Australia.

Zinc supplies are tight and will remain so as long as domestic consumption remains high, and higher prices abroad continue to attract Mexican zinc which is normally shipped to the United States. With this year's tin production estimated at 50 per cent of the pre-war rate, a good world-wide supply of the metal is not likely until 1950. Meanwhile, world tin stocks are being drawn down, despite restrictions on the uses of this metal.

Mond Nickel Fellowship

The Mond Nickel Co., Ltd., has announced its intention of awarding fellowships to selected British candidates of university or comparable educational standards. Successful aspirants will be trained in industrial establishments. The fellowships which will carry no age restrictions, will be five in number, tenable for a year, and worth £750. In certain special circumstances, university training may be awarded.

TENSILE STRENGTH OF METALS

Why Theory and Practice Conflict

MARKED distortion of the atomic arrangement has been found to be one of the important factors determining the tensile strength of metals, and that condition can be produced by artficial means, such as cold-working, alloying, age- or quench-hardening. This was one of the points to which attention was drawn by Sir Edward Appleton, secretary of the Department of Scientific and Industrial Research, delivering the Edward William's lecture to the Institute of British Foundrymen in Nottingham last week. He reviewed several of the fundamental problems which metallurgists have lately been studying and noted a number of important advances recently made to adapt metals, or produce new ones, to serve special purposes.

No Perfect Crystal

Of tensile strength, Sir Edward noted that it was not commonly found in simple metallic states. In order to explain the fact that real single crystals are far weaker than the ideal single crystals imagined by the theoretical physicist, it had been suggested that no real single crystals are ever perfect over other than very limited regions.

It was thought that there are in crystals numerous small faults where the crystal structure has got out of joint or out of step. A two-dimensional analogy is that instead of a row of atoms being directly opposite another row of atoms, one of the rows has one atom too many. The sliding of one plane in the crystal over another might be due to the progressive movement of the dislocations step by step across the crystal.

This produced the same effect as simultaneous sliding of the whole plane, although at any one moment only a relatively small number of atoms is moving, and in consequence, the force required to produce shear is seen to be much less than would be necessary if the crystal were really perfect.

This brought us to the problem of why polycrystalline crystals are so much stronger than single crystals. It seemed as if the extra strength of the polycrystalline material must be due in some way to the boundaries between the crystals. At these boundaries the atomic arrangement must be disturbed over a region a few atoms thick so that when yield occurs in a crystal and a dislocation arrives at a crystal boundary it is unable to cross the disturbed region and is dissipated.

An initial internal slip in a small crystal in a polycrystalline material was thus seen to be confined to the crystal in which it started and unless such slips occurred in many crystals simultaneously no plastic yield took place in the material as a whole.

On this theory it followed that if the number of crystals per unit volume was increased, either by the effect of cold working or by the introduction of alien atoms between the crystals, *i.e.*, by the formation of an alloy, the propagation of dislocations was impeded, which meant that the metal became stronger.

As Professor Andrade put it: "When a woman makes a cut in the edge of a piece of cloth and tears it, the tear will only run so long as the cloth is uniform; it will be stopped by a button-hole or a join between two pieces of cloth. In particular you cannot tear a patchwork quilt in that way."

MORE COAL FOR STEEL

INCREASED ALLOCATIONS PENDING

INCREASED allocations of an unspecified quantity of coal and coke for iron and steel production were announced by Mr. Herbert Morrison in the House of Commons last week. The steel shortage, he said, had been threatening to replace the coal shortage as the most vexatious and crippling bottleneck. Increased coal and coke allocations were being made with the object of giving the industry something like its full requirements during the summer.

They expected that in the summer months the industry would be able to produce at about the same rate as over the whole of 1946—about 12,700,000 ingot tons a year. In the last quarter of the year, they hoped to push production up to a rate of well over 13,000,000 ingot tons a year.

After a warning that with the uncertainty of the coal position the increased allocations were a venture of faith, Mr. Morrison pointed out even maximum home steel production was not sufficient to meet the unprecedented demands, while imports could do little to supply our deficiency.

Simon-Carves, Ltd., of Cheadle Heath, Stockport, will soon begin on a £1,000,000 contract for the constructon of a coke-oven and by-products plant for the Guest, Keen, Baldwin Iron and Steel Company, of Margam, South Wales. Another £500,000 contract has been placed with the Simon-Carves boiler department. This is for the construction of four water-tube boilers, each of which will generate 87,000 lb. of steam per hour.

"Industrial Wales" Exhibition

THE Wales and Monmouthshire Exhibition, to be held at Olympia from August 28 to September 13, is being promoted by the Industrial Association of Wales and Monmouthshire, whose president is Sir Gerald Bruce. Organiser and manager is Mr. B. M. Bellasis, whose office is at 3 Castle Street, Cardiff. Exhibitors already number over 100, heavy industries being represented by coal, steel, tinplate, chemical, quarrying and shipping interests.

Among the names appearing in the first two lists are the following: The Welsh Plate and Sheet Manufacturers' Association, National Oil Refineries, Ltd., Elephant Chemical Co., Ltd., Monsanto Chemicals, Ltd., Whitehead Iron and Steel Co., Ltd., R. Graesser, Ltd., and Metal Box Co., Ltd.

Among the exhibits that Thos. W. Ward, Ltd., will have on show at the Foundry Trades Exhibition at Olympia from August 28 to September 13, are the following: Foundry plant, furnaces, driers, mixers, screens, mixer-millers, sand conditioning plant, ladles, and miscellaneous foundry supplies. The pig irons will include foundry, forge, basic, hematite, low phosphorus and refined varieties. There will be a range of foundry cokes and moulding sand, together with ganisters, limestone, fluor spar, refractories, cinder, millscale, etc.

New Metal-Plating Process

AT a meeting of the American Electroplaters' Society held in Pittsburgh recently, George W. Jernstedt, manager of electroplating projects for the Westinghouse Electric Corporation, described a new plating process which flows metal atoms from solution on to an object, and then smooths and polishes them with an "electrical backstroke." The new method, he says, is better, faster, and less expensive than former methods, one manufacturer having been able to reduce the cost of plating a specific item by 50 per cent, with the added advantage of enhanced corrosion resistance.

According to Mr. Jernstedt the process produces a plate that is considerably smoother than the surface of the material to which it is applied, and by plating and deplating in a cycle, it is possible to obtain a plate of almost any desired thickness. Cyanide type baths such as copper, silver, zinc, cadmium, or even gold ore, he says, are best suited to the process.

Metallurgical Research and Training

CYRIL S. SMITH, director of the Institute for the Study of Metals, University of Chicago, has discussed the trends in metallurgical research and the training of metallurgists for the steel industry, in a paper which he read at the 55th general meeting of the American Iron and Steel Institute. New properties, he declared, could be achieved by the manufacture of new compositions, and the development of the science of metallography, the use of X-ray diffraction to study structure having particularly attractive potentialities.

The treatment of metals is known to be equally as important as its composition, and specifications of structure are frequently included. Most important of all, however, is the necessity of knowing the property actually required in service. But it is in the realm of physics that Mr. Smith believes radically new steps will be taken and really new materials appear. Mere empirical experimentation is much less likely to produce new discoveries than results from theoretical concepts backed by experiment.

Crosfield-Calthrop Combine?

A £250,000 deal which would lead to their amalgamation is being negotiated between two well-known Liverpool firms, Crosfields Oil & Cake Co., Ltd., and Calthrops, Ltd. Crosfields have offered to purchase the 400,000 ordinary 10s. shares of Calthrops at 12s. 6d. each, and a conditional agreement has been reached with the directors, who are recommending the shareholders to accept. The name of the new company would be Crosfields & Calthrop, Ltd.

Under the conditional agreement the purchasers have agreed to pay £16,000 to two whole-time directors and other employees of the company who will lose their employment. They have also agreed to continue to pay small pensions to four elderly workpeople for the rest of their lives.

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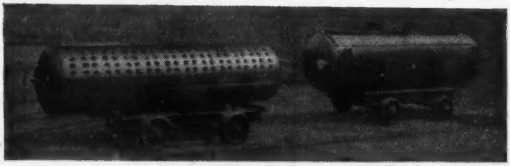

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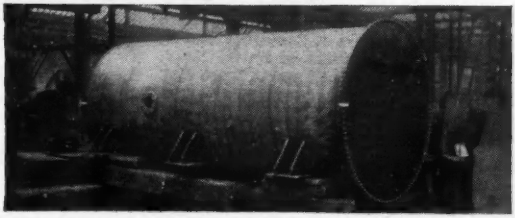

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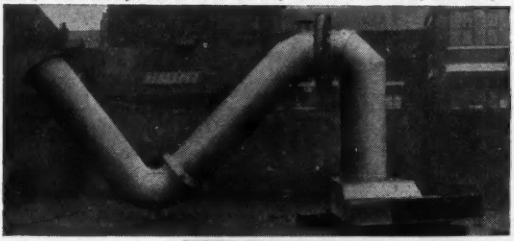

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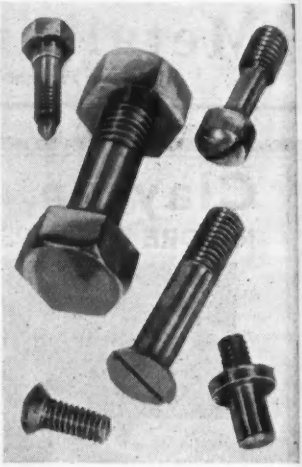

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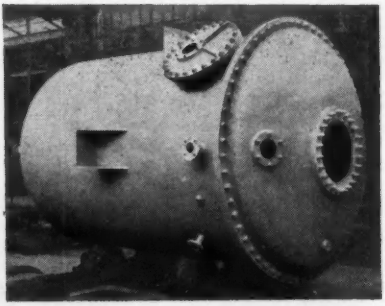

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PRECIPITATION HARDENING—V*

by L. SANDERSON

WE have earlier indicated that quench aging is the result of a modification of the characteristics of mild steel when it has been subjected to a severe quenching operation as the concluding stage in heat treatment. The extent to which it takes place is governed solely by the percentage of carbon in the material, and the structural condition is precisely that obtaining when ordinary hardening by precipitation occurs, the constituent precipitated being in this instance cementite.

There is, as yet, no agreement among metallurgists as to the precise correlation between carbon content and maximum hardness, but the majority view appears to be that 0.06 carbon gives the greatest degree of hardness, while if the carbon content exceeds 0.14 per cent there may not be any perceptible hardening effect.

Commercial Application

The only commercial use made of quench aging in relation to low carbon steel is in making spring wire such as is employed in upholstery For other commercial purposes, the maximum hardness increase being only about 50 V.P.N., and the decrease in ductibility being considerable, the effect is insignificant. It is commonly held that the decline in ability to withstand impact shock experienced when medium carbon steel is gradually cooled after it has been subjected to a tempering operation is also caused by quench aging. This effect is essentially that of temper brittleness.

The steels that can be aged have certain advantages. In the first place, because they acquire hardness and lose ductility when mechanically worked in the cold state, they possess improved machinability, the chips being readily broken off as a result of their brittleness, which means, among other things, that heat is carried away more quickly from the nose of the cutting tool. The larger the grain structure of the steel, the greater its machinability, and such coarse-grained steels are more responsive to aging. In fact, there seems to be a general correspondence between the conditions of coarse grain, machinability and response to aging. Powerful deoxidation appears to produce steels of fine grain, which are, in consequence, harder to machine and less sensitive to aging.

Steels that do not age, however, have other properties that are of commercial value. They have a greater ductility and tenacity, a greater damping capacity, and can resist plastic strain without cracking more effectively (the property known as "crackless plasticity").

From the practical point of view, aging and the modification of properties to which it leads are chiefly significant in relation to strain aging and its influence on the deep drawing and stamping of low and medium carbon steel sheets. In these, the ultimate stage in manufacturing operations before drawing begins is usually a light cold rolling to remove the yield point and thereby minimise the formation of stretcher strains. If the sheets are not put into service at once, aging will bring about a restoration of the yield point, and the liability to stretcher strain formation will recur.

When ordinary carbon steels, unalloyed, are subjected to a quenching operation, the hardness thereby produced is not generally considered to be an example of precipitation hardening, but in fact it constitutes a perfect instance of this form of hardening. The first stage is an allotropic modification of iron, which renders an extraordinary degree of super-saturation possible. Then comes a stage commonly known as critical dispersion, which is found directly on completion of the quench, and may be the minutest possible unit of precipitate.

Normal Process

The tempering operation applied to steels so quenched sets up a slow softening of the material, and this corresponds to over-aging in other systems. Let us consider what happens when ordinary ageing produces a hardening effect in steel. First, the quenching operation leads to the formation of a supersaturated solid solution, possessing stability at elevated temperature. Next follows the structural precipitation of a secondary decomposition product when the steel which has been quenched is reheated, after which come coalescence and softening. It should also be noted that isothermal tempering responds to identical laws. It is therefore evident that there are strong analogies between the two processes.

There are, of course, discrepancies between the treatment of steel and the ordinary aging treatment. For instance, here is a

* Previous articles appeared on February 1, April 5, June 7 and July 5.

discontinuity in the law of lowering of transformation points at A_r^1 as the speed of cooling rises, by reason of the allotropic modification of iron. Tempering of steel is more intricate, because when high carbon and alloy steels are quenched, martensite and austenite are found, while a number of elementary reactions may be experienced.

The discovery of the super high speed steel and certain other tool steels was speedily followed by the recognition that a considerable improvement in cutting properties could be achieved by a secondary hardening operation. The tendency today is to regard this increase in cutting power, resulting entirely from an increase in hardness, as the consequence of precipitation hardening, the precipitate being carbides other than those of Fe_3C.

Other Steels

Steels containing copper can be precipitation hardened, as long as the copper percentage lies within the range 0.4 to 3.5 per cent. The effect is produced by heating to a temperature in excess of 833°C., and then quenching, followed by tempering at temperatures above 400°C. for period up to a maximum of about 15 hours. The greatest hardening is developed with steels containing 1.5 per cent copper, which show a yield point of about 40 tons per sq. in., ultimate tensile strength of 49 tons per sq. in., elongation of 23 per cent, reduction of area of 55 per cent, and Brinell hardness of 223, these figures being produced by reheating for four hours at 500°C.

Quenching is not essential with these steels, because ordinary cooling suffices to produce the required structural condition as long as the speed of cooling is in excess of 2°C. per minute.

Precipitation hardened copper steels are, however, lacking in mechanical strength as compared with ordinary quenched and tempered copper steels, so that the process is rarely used save for castings of complicated form, which would be liable to crack if quenched. The precipitation hardened copper steels have the advantages of dispensing with the need for quenching, air-cooling being sufficient; absence of mass effect, so that it is possible without difficulty to treat steel of a diameter up to 11 in.; internal stresses are relieved without any softening of the material; and the steels have a higher corrosion resistance as far as atmospheric corrosion is concerned.

Treatment of Alloys

Magnet alloys of the Alni, Alnico and iron-cobalt-molybdenum types can be precipitation hardened, the most satisfactory method being to employ a high solution temperature, quench in oil or air, and follow with a precipitation treatment.

Invar and Elinvar, alloys used extensively where materials possessing low thermal expansivity are required, can also be precipitation hardened. Invar has to have approximately 3.25 per cent of titanium added to it to make it hardenable, and Elinvar also requires titanium to the extent of about 2.8 per cent. In both instances the hardening agent is believed to be Ni_2Ti.

Lead calcium alloys, of considerable value for storage batteries, are notably hardened by heat-treatment for 18 hr. at 100°C., and ageing at normal temperature. The calcium content is about 0.04 to 0.10. Standard silver as used in coins can also be precipitation hardened by heating it to 770°C. for half an hour, quenching, then tempering at 300°C. for another half hour, which trebles the hardness as compared to that of the quenched metal.

In conclusion, it is reasonable to suggest that eventually and at no remote period the metallurgist may be able to determine in advance precisely what characteristics any specific alloy of known composition will possess in any particular condition, which will entirely eliminate the necessity for complicated and protracted research.

[*Concluded.*]

German Iron Council

The liquidation of the various groupings in the steel industry which is at present in progress in Western Germany, has, according to recent reports, led a number of iron and steel firms to take the initiative in suggesting the establishment of an Iron Council, to be composed of eight members, drawn in equal numbers from the employers and trade unions. This council would have advisory functions in connection with the reconstruction of the iron and steel industry of Western Germany, and it would submit proposals of its own to the Military Government and to the German administrative authorities.

It appears that this suggestion originated within that group of industrialists, belonging to the powerful steel groups, which hopes to secure a stronger influence in the reorganisation of the industry. They point out that the new companies which were separated from the old groups, enjoy public subsidies which are not granted to the remaining enterprises. They fear, moreover, that any debts outstanding will have to be borne chiefly by the latter.

Co-op. Enters Fertiliser Field.—The firm of Messrs. James Wyllie and Sons, chemical fertiliser manufacturers, of Dumfries, Stranraer, Garleston, and Port William, has been acquired by the Scottish Co-operative Wholesale Society. This marks the entry of the S.C.W.S. into the fertiliser field as manufacturers and distributors on a large scale.

POWDER METALLURGY—II

First Results in Industrial Use

THE section on porous metal components (Section E of the Special Report No. 38, 1947, of the Iron and Steel Institute) contains much of interest; first, on porous bronze bearings which have long been known; and, second, on filters and aircraft de-icing equipment which are definitely new developments.

Carter and Metcalfe (Powderloys, Ltd., Coventry), who contribute the paper on porous bearings, give a brief description of the usual methods of manufacture; *e.g.*, sintering compacts made from a mixture of copper, tin, and graphite powders, with or without addition of a volatile compound, at temperature of 700-800°C. for 10-60 minutes. W. D. Jones recommends a double heat treatment, first at 400° and second up to 800°C. After sintering, the bearings are impregnated with oil in one of various ways and then "sized" as usual.

Study of Temperatures

An attempt is made to correlate the structure of these bearings, determined by X-ray diffraction, with other properties. Copper-tin-graphite mixtures were sintered, and results obtained by various combinations of compacting pressure and sintering times and temperatures were compared with the properties of the bearings examined. The peritectic reaction at 798°C. between the alpha solid solution and the liquid was found to be of prime importance in the usual sintering cycles, giving rise to sharp difference in structure and strength of bearings. It was thus possible to decide whether the sintering temperature used in manufacture had been below or above 800°C.

Sintered Products, Ltd., Sutton-in-Ashfield, have specialised for some time in the manufacture of highly porous metal compacts for various purposes including more particularly filters; and the paper by C. E. Sinclair describes the principal characteristics of these compacts. Considerable progress has been made both in this country and the U.S.A., but little information has hitherto been published; although the present writer in his patent review (THE CHEMICAL AGE, January 4, 1947) included one or two references to this subject.

In order to obtain the desired control over filtering efficiency it is necessary to use powders composed of graded spherical particles. Examples are given of the flow and pressure drop relationships of porous filters produced from such powders, together with micrographs of the pore size and shape.

Owing to high porosity, mechanical properties are low; but the compacts are ductile and have a shock resistance far higher than that of ceramic filters. The powder commonly used is of bronze formed by an atomising method in which a thin stream of falling molten metal is struck by a jet of air. Micro-photographs of the structure of Porosint are shown, and some of its special uses briefly noted, including (a) filtration or removal of unwanted material; (b) modification or adjustment of flow; (c) mixing of gases and liquids, as in yeast manufacture. The absorptive properties of the material are also often useful.

De-Icing Equipment

The aircraft liquid de-icing equipment, described by T.K.S. (Aircraft De-icing), Ltd., resulted from the urgent need in 1940 for a really satisfactory method of dealing with a serious impediment to winter and high altitude flying. Briefly, the device consists of a porous metal distributor, with a sintered copper-nickel-tin compact as the porous medium. The construction and operation of this system are described in detail, with some notes on practical application, from which it appears that ice at least 2½ in. thick can be removed. Practically all new civil aircraft are now fitted with this device. It should be added that Dr. W. D. Jones was one of the earliest to realise the possibilities of metal powder in this direction, and he has one or two patents in his name.

Before leaving the subject of porous metal components, mention should be made of paper No. 23 in Section F, by W. H. Tait (Glacier Metal Co., Ltd.), describing powder metallurgy bearing materials, with particular reference to plain bearings and thrust washers and to the unique qualities of metal powders of the copper-lead type for this purpose. Both porous and non-porous self-lubricating structures are described, with the usual steel backing for the powdered compact. For heavy loadings, tin powder is included in the mixture. The author thinks that the possible field for bearing materials is immensely widened by powder metallurgy, affording considerable scope for research with different powder mixtures and lubricants, under the most varied conditions.

Iron and Non-Ferrous Metals

Section F on sintered components may be roughly divided into sub-sections on (a) iron and iron-carbon (or graphite) mixtures and compacts; (b) iron-copper mixtures, copper powders; (c) aluminium and miscellaneous non-ferrous components; and (d) German progress.

In their paper on the properties of certain iron powder compacts, J. P. Burr and W. Clarke, of New London Electron Works,

Ltd., concentrate mainly on the effect of length of compact on density of electrolytic iron powders compacted under various pressures; also the effect on the tensile properties of such compacts of adding 1 per cent of stearin. Values for the probable pressure losses at the centres are tabulated. The effect of stearin was to reduce considerably the ultimate tensile strength and elongation of the straight sintered compacts; but the difference was less marked with the coined specimens, and when the compacts were re-pressed and re-sintered there was no difference in tensile strength, although elongation remained less with the stearin mixture. In the latter case, too, ejection pressure was reduced from 25 to 15 tons/sq. in. and ejection was more easy and smooth.

Iron-Carbon Alloys

The paper on iron-carbon alloys by J. A. Judd (British Piston Ring Co., Ltd.) is of fundamental interest and important, for it deals with the production on a commercial scale of sintered steels and their products noting the higher density and strength, excepting iron-copper alloys and high density pure iron parts, which are excluded from this comparison.

Dr. Judd discusses methods for increasing density and an essentially perlitic structure, and describes three ways by which sintered steels can be obtained. He emphasises that commercial considerations must limit pressures to 50 tons/sq. in. and temperatures to 1150°C. The three available methods are those using: (a) prealloyed steel or cast iron powder (b) mixtures of either pure or soft iron powder with graphite powder, forming iron carbide by sinterings; and (c) mixtures of either pure iron or soft iron powder with a smaller percentage of an alloy containing iron carbide. These are described in detail with their respective advantages and limitations.

It is concluded that, for the higher carbon alloys (hypereutectoid and graphitic steels) there is some advantage in mixtures of iron powder with iron carbide and graphite powder, since the iron carbide liquefies at sintering temperature, thereby strengthening the bond and improving physical properties. In this case, too, alloying elements may be incorporated which normally diffuse in sintering only with great difficulty.

Applications of this technique to production of aircraft piston rings are indicated; but it is clear that these powder metallurgy steels should have many important and varied uses. British Piston Ring Co., Ltd., already have numerous patents to their credit. The paper is of special value, in that it is based on actual large-scale manufacturing technique. The figures quoted are taken on actual ring blanks, and both elasticity modulus and ultimate strength were tested according to Air Ministry specifications for cast iron rings. The relation of these two factors to density is indicated.

An equally valuable but more general paper on iron-graphite powder mixtures and steel production was presented by R. Chadwick and E. R. Broadfield (I.C.I., Metals Division, Ltd.). This is copiously illustrated with curves and micro-photographs, and deals in some detail with the pressing, sintering, and heat treatment of varous grades of iron powder with graphite additions; the three principal types being (a) electrolytic, (b) charcoal-reduced Swedish, and (c) German Degussa powder. (Degussa = Deutsche Gold- u. Silberscheide Anstalt.)

Although differing appreciably in purity, the various iron powders did not vary much in general properties if they were annealed and fully reduced before use. Graphite additions facilitated rapid and effective diffusion of carbon at 1000°C. or above, forming perlitic structures, with ferrite or cementite, according to carbon percentage. Typical steels could be readily produced, and under suitable conditions could be heat-treated. Graphite additions were of the order of 1-2 per cent and sintering times up to 1 hour were used (at 1125°C.).

In regard to subsequent heat treatment, it was found that the conditions affecting quenching were complex: water quenching proved too drastic for highly porous compacts, and it is concluded generally that effective oil-quenching involves permeation of the porous structure.

Iron-Copper Powders

The same authors have also supplied one of the interesting papers on iron-copper powder mixtures; the other coming from the Armament Research Department at Woolwich. R. Chadwick and co-workers studied effects of variation in particle size, pressure, and sintering temperature on properties of iron-copper compacts containing up to 35 per cent copper. The iron powder was either (a) electrolytic, from ferrous ammonium sulphate solution; (b) reduced from scale of mild steel steel turnings by cracked ammonia; (c) charcoal-reduced Swedish, or (d) American mill scale powder. The copper was either electrolytic or hydrogen-reduced.

Copper and iron form no brittle phases, and it is possible to obtain strong sintered compacts over a wide range of composition, optimum strength and ductility being obtained with a 75/25 iron-copper mixture, at temperatures high enough to melt the copper-rich phase powders finer than 240 mesh B.S.S.

Compressibility was one of the most important factors. Compacts made from the readily compressible electrolytic powders shrink less than those made from the less compressible hydrogen-reduced powders;

but the latter types shrink to a greater extent in sintering, and therefore higher tensile strength and ductility are generally obtained in the products.

The paper from Woolwich also gives results of study of sintered compacts of iron-copper alloys; and here again substantial improvement in tensile strength and hardness, as well as increased scuffing load, are observed with up to 25 per cent copper. The advantage of sintering above the melting point of copper is shown in the microstructure. Improvement generally is greatest with copper of small particle size, but this may not be true with coarse particle irons.

High density compacts are obtained by impregnation of pressed iron compacts with molten copper. There is close relation between tensile strength and equivalent density (referred to by J. A. Judd), irrespective of the method of manufacture; but for constant porosity maximum strength was obtained with about 10 per cent copper.

It is concluded that the essential purpose of copper additions is to increase particle cohesion; and modifications in composition or sintering technique which aid this process will also improve mechanical properties, if the copper addition is not too great, while sufficient to confer its low strength to the compact.

Comparative Study

I.C.I., Ltd., Metals Division, in recent years have devoted much time and research to the study of copper powders. Cook and Pugh (paper No. 24) point out that, although prior work in this field has contributed useful information, there has not been a critical comparison of powders of different types. They have endeavoured to make this comparative study, and have investigated copper powders of varied origin, studying behaviour in pressing and sintering in relation to particle shape and particle-size grading or distribution.

Three different types of copper powder: electrolytic, reduced, and chemically precipitated, were examined in regard to physical properties, including compressibility, dimensional changes in sintering, as well as tensile strength and ductility of sintered products. A full discussion of results is well illustrated with curves and microphotographs.

Brass and bronze engineering components by powder metallurgy are dealt with in paper 25, by J. W. Lennox (Sintered Products, Ltd.). Methods and properties in respect to a 70/30 brass and a 90/10 bronze are described in detail, together with some of the resulting components made by mass production methods.

One of the principal difficulties in producing aluminium powder is probably oxidation, and in this paper (No. 26) R. L. Bickerdike, of the Royal Aircraft Establishment, Farnborough, reviews methods of obtaining oxide-free powders, and describes experiments on the hot- and cold-pressing and sintering of copper-aluminium powders. As was to be expected, the pressure and sintering temperature used were found to have a critical effect on the properties of sintered compacts. Test pieces in the form of discs were employed and results are presented of microscopical examination, density and hardness measurements, and tensile test.

German Progress

Of the two papers on German progress in recent years, the first by C. J. Leadbeater, of the Armament Research Department, Woolwich, is noteworthy for the very comprehensive list appended of BIOS and CIOS reports dealing partly or wholly with powder metallurgy and its applications in Germany. The author briefly surveys these, including types of equipment and its applications in Germany.

Several significant developments occurred in powder production. The flake powder industry was reorganised and re-equipped for producing pyrophoric aluminium (13,000 tons/year) while production of iron powder exceeded 3000 tons/month. Disc- and air-atomisation methods for iron powder yielded satisfactory grades of product, increased rates of output, and appeared likely to supplant the mechanical Hametag process with its relatively low rate of output and high capital and maintenance costs. Molybdenum powder of greater purity was obtained by distilling the oxide before reduction.

Only a few types of components, such as driving bands, bearings, and filaments, were made on a commercial basis, although many, chiefly of dense steel, had reached the development stage. An ingenious arrangement of sprung sub-multiple punches had been devised to attain a uniform compression-ratio in components of complicated shape. Hydraulic and mechanical presses were in general use, with multiple die-stations for pressing small bearings and bullet cores.

Further details of driving bands made from sintered iron are given by W. Ivory, also of the Armament Research Department, together with a general review of German war-time production of iron powder, of which 93 per cent was used in the production of driving bands. Some of the principal advances in technique during the war are indicated, including continuous resistance furnaces of the molybdenum wire wound type, hard metal linings for dies, study of grain characteristics and their significance, and introduction of new processes, especially the RZ in which atomisation was used, with high carbon steel as raw material.

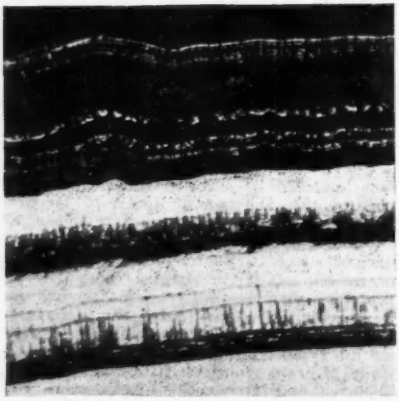
[*The first part of this review was published in our issue of July* 19.]

Electroless Plating on Metals by Chemical Reduction

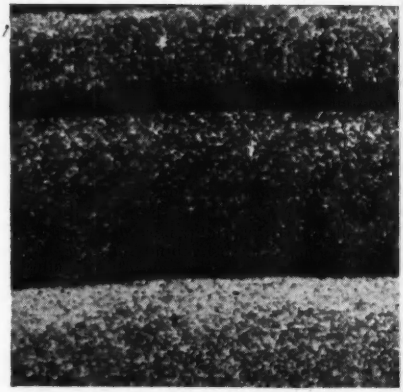
A NEW method for plating nickel and cobalt on metal surfaces without the use of electric current, known as electroless plating, and brought about by chemical reduction of a nickel or cobalt salt with hypophosphite in hot solution has been developed by Abner Brenner and Grace E. Riddell of the U.S. National Bureau of Standards. The reaction is catalytic, and under the prescribed conditions of concentration and *p*H, no plating occurs unless certain metals, such as steel or nickel, are introduced in the bath. The reduction then occurs only on the surface of the immersed metal with the production of an adherent coating of 93 to 97 per cent purity.

Photomicrographs of deposits obtained in this way show both a laminar and a columnal structure, similar to bright nickel electrodeposits. The electroless deposits are of good quality—sound though brittle, and unusually bright. Since they can be made as hard as tool steel, the method may prove useful where hard, wear-resistant surfaces are required, as in bearings. The process is particularly applicable to the plating of recesses, irregular-shaped objects, and enclosed areas such as tubes, where a centred internal electrode with special current leads would be needed in electroplating.

The equipment is simple, more easily assembled than that required for electroplating and no generators, rheostats, special racks or contacts are required. Small parts which cannot be barrel-plated economically



are readily plated by the electroless process if suspended by a string or in a bag affording ample exposure of the metal surface to the solution. There is no need of constant motion, as in barrel plating, since current distribution is not involved.



While electroless deposits of cobalt and cobalt-nickel alloys have been obtained only from ammoniacal solutions, nickel can be deposited from either acid or alkaline solutions. The reactions, requiring a temperature above 90° C. are given in the following equations (in which cobalt may be written for nickel):

$$NiCl_2 + NaH_2PO_2 + H_2O \rightarrow Ni + 2HCl + NaH_2PO_3$$

or $$NaH_2PO_2 + H_2O \rightarrow NaH_2PO_3 + H_2$$

The first reaction is the important one, resulting in the deposition of nickel; the second reaction tends to lower the efficiency of the process through oxidation of the hypophosphite.

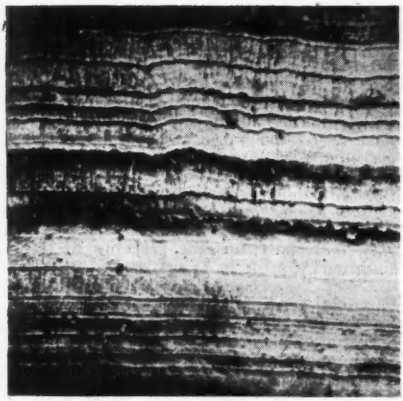
A unique feature of the electroless process is the catalytic initiation of the reaction by the following metals: Iron or steel, nickel, gold, cobalt, palladium, and aluminium. Unless one of these metals is introduced into the solution, no reaction takes place. Once started, the reaction continues at the metallic surface and only rarely occurs in other parts of the bath. For this reason, the containing vessel is of glass, plastic, or other non-catalytic material.

Objects to be plated can be cleaned by any of the accepted procedures and given an acid dip before being suspended in the hot solution. The rate of deposition is about the same as in barrel electroplating, ranging from 0.0002 to 0.0008 in. per hour, depending on the type of solution used. During the process, the *p*H is kept within

a certain range, and if the operation is of long duration, the nickel salt and hypophosphite are replenished at regular intervals.

The composition of the plating bath may vary within rather wide limits. Suggested solutions are given in Table 1.

In addition to the metal ions and hypophosphite, the alkaline solutions contain (1) hydroxycarboxylic salts and ammonium salts to prevent precipitation of the metal salts, and (2) certain alkalis to regulate the *p*H. In the acid nickel solutions, organic acids are used as buffers.



Electroless plating on non-catalytic metal surfaces may be accomplished in two ways. If a film of palladium or rhodium of nearly monatomic thickness is first applied by chemical replacement on a non-catalytic metal, deposition of nickel or cobalt will occur on the activated surface. Electroless plating of copper may be carried out in this way. A second method of initiating the reduction is to bring a less noble metal, such as iron or aluminium, in contact with the non-catalytic metal while it is immersed in the hot electroless solution. Once the process has been started, it continues because of the catalytic action on the initial deposit.

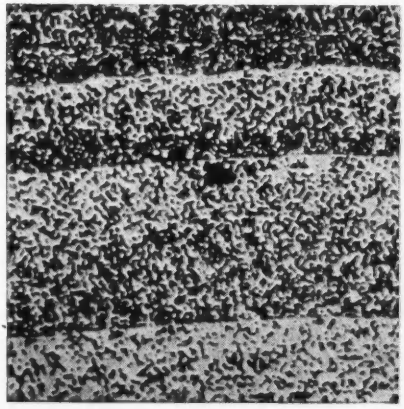
As formed, the electroless nickel deposits are brittle but become ductile when heated. These deposits are harder than the ordinary electrodeposited nickel, and upon heating their hardness is still further increased. This is in contrast to the behaviour of "hard" electrodeposited nickel, which has high initial hardness but softens upon heating. The hardening may be explained as "precipitation hardening," probably of phosphides.

The adhesion of the nickel deposit to mild steel is such that it cannot be flaked off by bending, but on high-carbon steel this property is less satisfactory. In salt-spray tests on steel coated with 0.0002, 0.0005, and 0.0001 in. of electroless nickel, in comparison with similar panels coated with electrodeposited nickel, the protective value of the two types of coatings was virtually the same. However, the electroless cobalt does not compare so favourably with electrodeposited cobalt.

The yield or efficiency of the reduction based on the decomposition of hypophosphite is 37 and 66 per cent for nickel and cobalt, respectively. About 2 grams of nickel or nearly 4 grams of cobalt are reduced by 10 grams of sodium hypophosphite.

TABLE 1
Suggested Compositions for the Various Electroless Solutions

	Nickel			Cobalt-Nickel
	Alkaline	Acid	Cobalt	
	g/l	g/l	g/l	g/l
Nickel chloride, $NiCl_2.6H_2O$	30	30	—	30
Cobalt chloride, $CoCl_2.6H_2O$	—	—	30	30
Sodium hypophosphite, $NaH_2PO_2.H_2O$	10	10	20	20
Sodium citrate, $Na_3C_6H_5O_7.5\frac{1}{2}H_2O$	100	—	35	—
Rochelle salt, $NaKC_4H_4O_6.4H_2O$	—	—	—	200
Sodium hydroxyacetate, $NaC_2H_3O_3$	—	50	—	—
Ammonium chloride, NH_4Cl	50	—	50	50
Alkali for neutralising	NH_4OH	NaOH	NH_4OH	NH_4OH
*p*H	8-10	4-6	9-10	8-10
Rate of deposition, mm/hour	0.008	0.015	0.015	0.015
Rate of deposition, inch/hour	0.0003	0.0006	0.0006	0.0006
Appearance of deposit	Bright	Semi-bright	Dull	Semi-bright



CONDITIONS IN IRONFOUNDRIES

IMPROVEMENTS RECOMMENDED

THE result of two years' study of working conditions in ironfoundries by a Joint Advisory Committee under the chairmanship of the Chief Inspector of Factories (Mr. H. E. Chasteney) is the subject of a 34-page report published this week under the auspices of the Ministry of Labour (Report of the Joint Advisory Committee on Conditions in Ironfoundries; H.M.S.O., 6d.).

The main objectives of the committee were to recommend means of securing (1) better amenities and more comfortable and healthy working conditions, (2) improved appearance of ironfounders by greater cleanliness, orderliness and more light and colour, and (3) improved atmospheric conditions. It recommended that a Joint Standing Committee should be formed to keep under continuous review conditions affecting the health, welfare and safety of members.

2000 Foundries

There are in Great Britain (says the advisory committee report) about 2000 ironfoundries differing greatly in size and methods of production and producing castings ranging from an ounce up to approximately 150 tons. Some foundries—particularly in the automobile section of those constructed or equipped for special war purposes—are highly mechanised, while in others—especially the smaller jobbing foundries—methods have not changed appreciably during the last 50 years. There is thus a very wide variation in the circumstances of different foundries and this has necessitated some flexibility in the nature and application of our recommendations.

In common with other old industries, many ironfoundries suffer from being housed in poor premises built in days when too little attention was given to working conditions, and this will remain as a fundamental defect until rebuilding can be undertaken. In order that the deficiencies of the past may not be repeated we have included in this report a section summarising some of the main considerations in this respect which should be kept in mind in the design and lay-out of new foundries.

While questions of methods of production are outside our terms of reference, the committee has an interest in the matter because mechanisation of a foundry often enables problems of dust and fume removal to be tackled much more simply and effectively, besides reducing the amount of heavy manual work to be done. We would therefore welcome an increased use of mechanical aids and a wider adoption of labour-saving devices.

It is to be regretted that in many foundries little attention seems to be paid to "good housekeeping," with the result that heavy equipment is dumped anywhere about the foundry, and materials and gear of all kinds are scattered about indiscriminately on the floors, and the general impression is one of confusion and lack of system. The impossibility in such circumstances of keeping gangways clear, and the litter on the floors adds greatly to the hazards of the work and prevents proper cleaning.

On the other hand, very different conditions are to be seen in foundries where the significance of good housekeeping has been fully appreciated. Mechanisation assists very materially towards securing desirable standards, but it is by no means an essential factor, and some of the non-mechanised foundries are among the best kept.

Owing to the presence of furnaces, stoves and molten metal in ironfoundries, it might appear that the main difficulty in controlling the temperature would be to prevent it from becoming unreasonably high rather than to raise it to a desirable level. Some parts of foundries however, for example, dressing shops, are often remote from such sources of heat; and in foundries where casting is intermittent or is confined to the afternoon, cold conditions may be and often are experienced on a winter's morning, even in moulding shops, if adequate measures are not taken to warm the premises.

Cold Delays Work

During spells of very cold weather it is not uncommon for the commencement of work to be delayed because the sand has frozen overnight and the moulders are unable to manipulate it. In order to make the sand workable it is a common practice to use open fires which frequently produce volumes of smoke and fumes and make working conditions extremely unpleasant. From evidence which we have received, it is clear that the question of securing a reasonable temperature has not received the attention it should have had and that very often the means of heating provided are insufficient and unsuitable.

We are agreed that no open fire should be used for warming a foundry. We also feel that mould driers should not be used for this purpose even though they may be considered suitable for other purposes when used under properly controlled conditions.

After taking into account all the information so obtained and the views expressed by foundry occupiers and managers and heating specialists who were consulted, we are

of the opinion that it would be generally practicable to attain a temperature of at least 50°F. at working positions within one hour of starting work. It would, however, in our opinion, be unreasonable to insist on the installation of extra heating equipment for the purpose of raising the temperature to 50°F. on the comparatively rare occasions when the outside temperature falls below 30°F., and we feel that it would be sufficient on such occasions if an inside temperature of not less than 20°F. higher than the outside temperature were obtained.

Some Exceptions

Open coal or coke fires and mould driers should not be used for the purpose of heating rooms in ironfoundries. We are of the opinion that the elimination of open fires from ironfoundries is necessary if the best possible conditions are to be attained, but we appreciate that, although their use can be discontinued in many instances, it may be unavoidable, at present, to use them in certain cases owing to the fact that suitable alternatives are not available. For example, there does not appear to be an adequate substitute for the open fire in the process of "burning" which would satisfy all conditions.

The use of an open fire may also be necessary in heavy foundries for certain operations such as the heating of lifting hooks, the heating of plates or bricks for drying core lifting holes after they have been made up and for the drying of cores which have been damaged and repaired or which require final adjustment to size when closing.

The committee finally recommends that: Every effort should be made to avoid the use of "ordinary open fires" in ironfoundries. The industry should endeavour to develop technique to eliminate their use in those processes in which no suitable alternative is at present known.

Where the exceptional use of an open fire can be shown to be unavoidable, all practicable measures should be taken to protect the persons employed against inhalation of fumes or other impurities and to prevent their accumulating in any workroom. In particular a freshly lighted open fire should not be brought into a foundry while it is giving off visible fumes or smoke, but only after it has commenced to burn brightly. It should be removed from the foundry immediately after the work necessitating its use has been completed.

Designing New Foundries

The commonest method of drying and heating ladles is by the use of a wood or coke fire. During this operation the atmosphere is liable to become thick with smoke and fumes. In our opinion the most satisfactory way of dealing with the matter is to arrange a special ladle drying and heating station at which suitable measures are taken to prevent smoke and fumes from escaping into the general atmosphere of the foundry. Such a station is desirable not only because it facilitates the adoption of these measures, but also because it helps in establishing more orderly conditions by concentrating ladle drying and heating in a recognised place. We consider that such stations should be provided in all new foundries and that every effort should be made to provide them in existing foundries although it is appreciated that this may not be possible in all cases.

Among the many other aspects of ironfoundry work on which the committee recommends changes in procedure are canteens, washing and cloakroom facilities, the introduction of light and colour and reduction of noise, dust and fume, and a number of foundry operations, such as the easing of castings, "knock-out" and dressing operations. There is also a section studying in some detail desirable design and constructional rules for new foundries.

Synthetic Rubber Plans

A drop of two cents a pound in the price of buna-S synthetic rubber, from 18½ to 16½ cents a pound, was announced by Rt. Hon. C. D. Howe, Canadian Minister of Reconstruction. Buna-S, principal product of the State-owned Polymer Corporation plant at Sarnia, Ont., was marked at the new price on June 1. Earlier, Mr. Howe had conferred with members of the Polymer group of directors concerning the recent drop in the price of natural rubber and announced that among the steps being taken in anticipation of the drop in the value of natural rubber was the gradual evolution of the plant as the hub and supplier of a new chemical industry on a very large scale. Buna-S production costs had also been continuously reduced.

Buna-S and butyl were reduced in price last November from 20.35 cents a lb. to 18½ cents. The new price of 16½ cents is more than 19 cents lower than when Polymer first began operations in September, 1943. Price of butyl rubber remains unchanged at 18½ cents a lb.

B.I.F. 1948

The British Industries Fair 1948 is to be held in London and Birmingham from May 3-14 and forms of application for space are shortly to be sent to manufacturers. The Board of Trade urges that the forms be completed upon receipt, and promptly returned in order to facilitate early allotment of space.

French Iron-Ore Mining

THE recently issued report of the French Association of iron-ore mines (Chambre Syndicale des Mines de Fer de France) contains interesting details and figures about the development of this highly important branch of France's extracting industries. Output of iron-ore (in million metric tons), showed a welcome increase in 1946 to 16.2 from 7.7 in 1945, while 13.7 million tons were distributed in 1946 compared with 5.3 in 1945; stocks rose thus from 5.7 to 8.0 million tons. The domestic market absorbed 8.2 million tons, compared with 3.6 a year ago, while exports rose from 1.7 to 5.5, with Belgium and Luxembourg the chief customers, although they took only about one-half of the customary pre-war quantities. Deliveries to the Saar, which was formerly an important outlet, aggregated only about one-sixth of the pre-war level. The following table gives a survey of the development of French iron-ore mining (figures in million metric tons) :—

	1929	1937	1945	1946
Output	50.7	37.9	7.7	16.2
Distribution ...	50.2	38.8	5.3	13.7
Stocks	2.7	1.9	5.7	8.0

The labour force increased last year by 2479 and totalled at the beginning of the current year 24,637 persons. A noteworthy improvement took place also in the output per man, which rose in the Lorraine mines from 4.7 metric tons per underground miner in December, 1945, to 5.5 metric tons in December, 1946.

Low Prices

Although this statistical position is proof of the recovery that has been achieved in France in the teeth of great difficulties, the financial position of the iron-ore mining companies is, according to the annual report referred to above, far from satisfactory. The Government is blamed for this by fixing selling prices which do not cover production costs (claimed to have risen by 45 per cent) resulting in heavy losses to the companies. The Lorraine mines alone are reported to have lost about 600 million francs last year; total losses, since the middle of 1943, are said to amount to no less than 1.7 milliard francs. The companies protest that price increases are granted only after considerable delay; for instance, after wages had been increased by 30 per cent in July last year, prices were not increased until the middle of September, from 174 to 280 francs per ton of Lorraine minette, of which 45 francs have to be paid into a special re-equipment fund. Should total output total 19 million tons for the current year, this fund will receive some 800 million francs. The usefulness of this measure is not being contested, but the report expresses the hope that a more economical working may be achieved in future.

U.S. Aluminium

THE production of primary aluminium in the U.S.A. has shown large increases in recent months. Figures just issued by the U.S. Bureau of Mines show that there was a strong rise in the latter part of 1946, after the strongly marked recession in the previous year, and the total produced in March this year, 53,032 short tons, was the highest recorded since August, 1944. Production in the first six months of 1946 fluctuated between 22,000 and 28,000 tons per month and rose steadily to 50,700 tons in December. After holding approximately the same level throughout January this year, metal production fell back in February to 47,000 tons. The March total represents an increase of slightly more than 6000 tons.

The daily average output of aluminium reduction works in February was 1678 tons, representing 4 per cent more than the average in January, and was the highest for 21 months. The total was lower, because of the shorter working month.

The Civilian Production Administration estimated the year's requirements to be 800,000 tons against domestic production of 550,000 tons. To meet the deficiency 28,665 tons were made available from Government stocks in January and February. In the same period producers' virgin metal stocks rose 6722 tons to 21,444 tons, or scarcely two weeks' current use rate.

Pyrites Residues for Germany

Conclusion of a contract between the Rio Tinto Company and the Duisburg Copper Foundry regarding the processing of 120,000 tons of pyrites residues, to be delivered by the Rio Tinto Company, has been announced by the American Military Government in Germany. In payment for the processing, the German company will receive a share of the products for use by the German export industry. The contract provides for further consignments of pyrites to Germany later under similar conditions.

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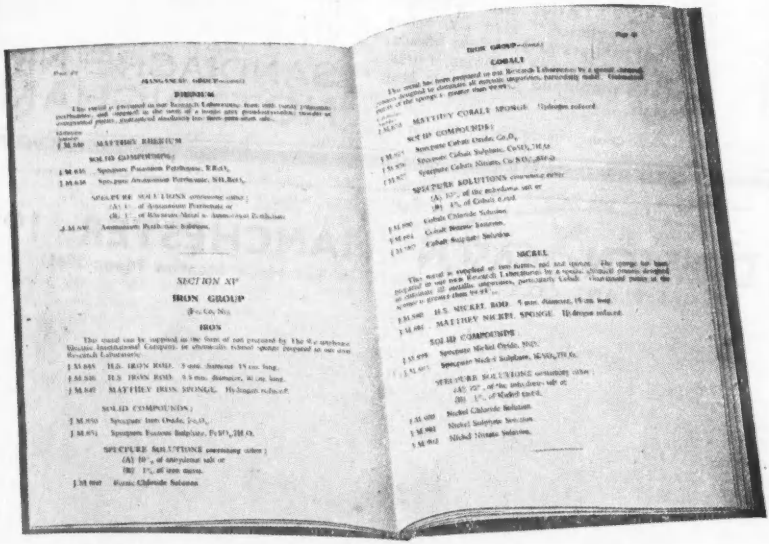

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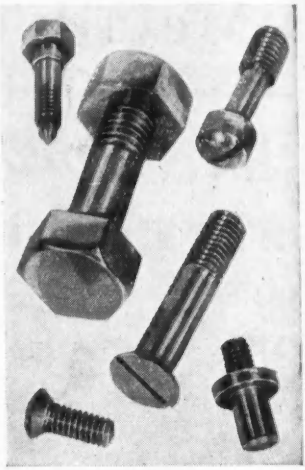

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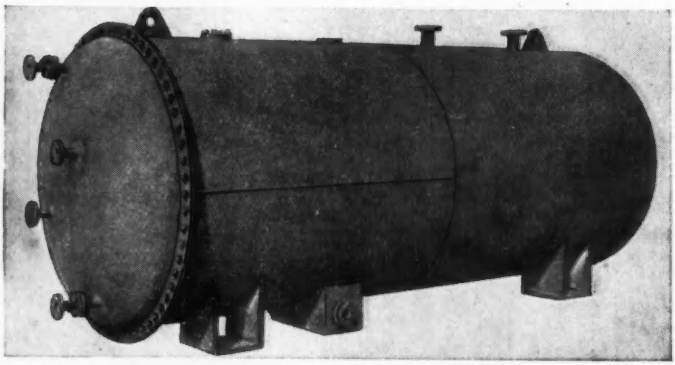


Illustration shews M.S. Rubber Lined Tank for Hydrochloric Acid

TANKS. CYLINDRICAL AND RECTANGULAR

PUMPS AND FLOW METERS, ETC.

Metallurgical Section

6 September 1947

ELECTROLYTIC LEAD FOR RESEARCH PURPOSES

by A. G. AREND

THOSE desirous of keeping up-to-date with modern industrial conditions will be aware of the continued encroachment of electrolytically refined metals on those which formerly were prepared by smelting methods. This applies alike to copper, nickel, tin, and to a lesser extent to zinc. On the one hand, almost perfectly pure metal is obtained in each case with the most favourable physical characteristics for fabricating or alloying purposes, or for electrical uses, while alternatively, all associated rarer constituents are simultaneously recovered. Until the closing stages of the recent war, lead differed in these respects, as the moderately pure metal sufficed for all normal purposes, ranging from plumbing and chemical constructional work to cable sheathing, and fine packaging, etc. The fact that this metal could be rolled out to thin foil was no indication that it was perfectly pure, but simply that it was free from excessive impurities. Lead is so readily obtained by direct smelting methods in blast-furnaces, that even to this day, the majority of it hails from this source. Refining methods in earlier years more related to skimming practice, and application of the Parkes and Pattinson processes for separating silver, etc.

Ever-increasing Demands

Electrolysis opened up a fresh field in that all associated impurities could be recovered from the anode slimes, but earlier applications did not enjoy popularity, as there was no great demand for pure lead, and further they were fraught with many practical difficulties. To-day, events alike in nuclear researches, and radiology, reveal only too clearly that perfectly pure electrolytic lead has become ever-increasingly in demand. Details of how lead screens are engaged in atomic energy pursuits, and of "X"-ray rooms which are completely lined with sheet lead, let alone those constructed of lead-clad plywood to provide other barriers and shields, require little in the way of advertisement, as they are fully known to all scientific investigators. Interest in perfectly pure lead, as distinct from ordinary electrolytically refined lead, has thus become correspondingly greater. Although the same remarks apply to cadmium, beryllium, and indium, this relates to specialised uses, whereas pure lead can be turned to account for a wider range of applications. A perusal of recent literature on nuclear researches will reveal how difficulties were encountered in acquiring pure graphite, heavy water, and other commodities, all of which are made by exacting electrolytic practice. Lead did not give complications in the same way, since repeated treatment could produce it with total impurities of less than 0.0006 per cent.

Initial Electrolytic Refining

The production of this lead involves both large-scale electrolysis to provide first a metal which contains little more than 0.008 per cent of total impurities, and then smaller scale electrolysis to produce sheets of the perfectly pure metal. The reason why electrolytic refining of scrap lead has not been persevered with is that the original metal had already been desilverised, while most bismuth, and any other constituent of value had been removed.

It is thus a better paying proposition to start with crude lead as delivered from the blast-furnace, and have this cast as anodes and electrolysed. This procedure enacts the dual operation of refining and accumulating most impurities in the anode sludge, or leaving them in the electrolyte. Where the lead is too impure, it is subjected to skimming treatments as a preliminary, and to ensure smooth uniform deposits, should be about 97 per cent pure. The conditions of the electrolysis require careful control to acquire the highest current efficiency, which should never fall below 90 per cent, and with good working can be much higher. Asphalt-lined wooden tanks are used, but are set-up in different systems, as the cascade arrangement with double rows of 5, 6, and 11 tanks has a competitor in an alternative system of 4 tanks in a row, which provides considerable economy in bus-bar copper. This is because copper triangle bars of small cross-section conduct current from the cross-rods of the cathodes of one tank to the anodes of a neighbouring

tank, while it is only at the ends of the sections that bus-bars are used.

A gravity feed tank distributes the electrolyte to the tanks, which liquor is later returned by a system of centrifugal pumps, suitably lined to minimise corrosion. This circulation causes the liquor to flow at the rate of from 2½ to 4 gallons per minute through each tank, while a temperature of approximately 40° C. is maintained.

Whereas a multiplicity of electrolytic compositions have been proposed for lead refining, and have appeared in patent literature, only fluosilicate solutions are used at the first stage, although ultimately, an alternative electrolyte is necessary for depositing the perfectly pure metal.

Preparation of this fluosilicate is done in an adjoining plant where a mixture in the ratio of 2½ lb. fluorspar and 3 lb. sulphuric acid (66° Be.) is distilled to give hydrofluoric acid, which is then run through selected silica sand. (Since the war ended, fresh compositions of silica-free glass have made it possible to conduct this entire operation in glass containers). Before commencing the electrolysis, part of this liquor is converted to lead fluosilicate in small cells using lead anodes and cathodes, separated by a diaphragm, and which require some 1.25 volts per cell. The liquor so obtained is then pumped into the electrolysis tank proper, where it is maintained so as to contain 8 per cent free hydrofluosilicic acid, and approximately 6 per cent lead. Cast anodes of some 4 cwt. are used with dimensions of 2 ft. by 3 ft., and about 1¼ in. thick, and the electrolysis is continued until these have been reduced to a mere skin. The cathodes are simply thin sheets of pure lead, slightly larger in size than the anodes, and which are made by pouring the molten metal over inclined cast-iron plates.

The anodes and cathodes are arranged in the tanks at a spacing of between 4 and 5 in. Current is applied at 16 amps per sq. ft. of cathode surface, while from 18 to 21 lb. of lead, depending on the resistance set-up and the current efficiency, is deposited per kilowatt-hour.

Conversion to Highest Quality Lead

In actual practice, the conditions are varied from time to time according to the crystalline tendencies of the deposit, and no one set of conditions will suffice. For example, slower deposition by using only 9 amps per sq. ft., with an electrolyte of 11.5 per cent free hydrofluosilicic acid, and 8.3 per cent lead, is resorted to for ensuring a good coherent deposit. The addition of a minute proportion of gelatine to the extent of 0.01 per cent, improves this deposition. By dint of appropriately manipulating the conditions, it has been possible to attain a cathodic current efficiency of 98 per cent. With good working, discard left from the anodes should not exceed 18 per cent, while total corrosion should not require more than 4 days. Lead so obtained contains little more than 0.008 per cent of impurities, and thus suffices for all ordinary industrial purposes, but for the more exacting nuclear and "X"-ray activities which have developed so widely, this is insufficiently pure. In detail, the impurities are made up of 0.003 per cent each of bismuth and antimony, 0.0008 per cent iron, 0.0007 per cent zinc, and 0.0003 per cent copper, while silver varies around 0.0004 and 0.0006 per cent. The conversion of this product to pure metal would not be commercially economical for ordinary purposes, as the electrolysis has to be repeated. By so doing, however, it is possible entirely to eliminate antimony and silver, and reduce the others to negligible proportions. The total impurities are thus brought down to some 6 parts per million of lead, half of which is represented by iron, and the remainder sub-divided between bismuth, copper, and zinc.

Sheets for Anodes and Cathodes

Unlike the large electrolysis baths engaged in the foregoing work, the process is now carried out on a more or less laboratory scale, with anodes of small weight, giving a total product of from 20 to 80 lb. per run. The lead obtained by the first electrolysis is initially rolled out in thin sheets alike for anodes and cathodes, although it has sometimes been necessary to melt it, to get rid of small inclusions and gas pockets, prior to rolling. The anodes are cut off from the rolled sheet in sizes of 1½ ft. by 1 ft., at thicknesses of little more than one-tenth of an inch, although more rigidity can, of course, be ensured by using greater thickness. Instead of preparing lead fluosilicate and free hydrofluosilicic acid chemically, as in the former instance, perchloric acid, and perchlorate of lead are prepared independently in a small electrolysis vat. This is done between platinum-lined electrodes, commencing with sodium chlorate as the raw material. The process follows the method originally outlined by F. C. Mathers, but which although operating with electrolytes of greater stability, and higher conductivity then the fluosilicate solutions, could not compete with these, and was thus limited to smaller demands for perfectly pure lead. The tanks are arranged on the same lines as the large-scale process, with a continuous flow of the electrolyte, and an overhead storage tank which feeds them. A small centrifugal pump, operated at fixed intervals by a mercury switch actuated by a ball-float mechanism maintains the level of this storage tank. The liquor is caused to pass through a filter-press continuously

(*Continued on page* 332)

IRON, THE KEY TO AUSTRIA'S PROSPERITY*

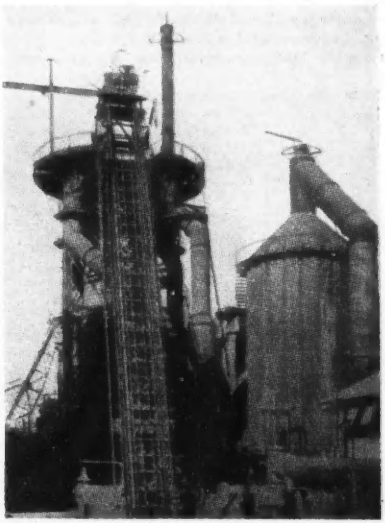
Iron and Steel Production Reviewed

THERE are few single industrial plants in Europe which bear such a vital relation to the fortunes of the country in which they are located as does the Donawitz Iron and Steel Works in Austria. The little town of Donawitz which houses the main plant of the great "Alpine Montangesellschaft," lies in Northern Styria (British zone) north of Leoben, in beautiful natural surroundings.

Importance to Austrian Economy

The works has four blast furnaces, fourteen open-hearth and three electric steel furnaces, with a capacity of some 450,000 tons of crude steel a year, and rolling mills capable of dealing with practically the whole of its steel output. The significance of its capacity to the Austrian economy will be appreciated by the fact that, in 1937, the country as a whole produced only 650,000 tons of crude steel and about 450,000 tons of rolled steel. Donawitz and the nearby sister plant at Eisenerz produced between them the whole of Austria's pig iron output (some 390,000 tons) which fed the steel furnaces not only of Donawitz but of all other Austrian steel works and iron foundries, and in addition provided an export surplus which in 1937 was as high as 54,000 tons. Donawitz alone produced considerably more steel than Austria could consume and together with Böhlers, Schöller-Bleckmann and other producers, contributed about 14 per cent of the value of Austria's visible export trade. The ore for Donawitz is mined and brought by train from the nearby ore mountain at Eisenerz which has a rather terrifying grandeur which emphasises its natural riches and tremendous industrial value. The ore mountain, which rises to a height of 2725 ft., has been hewn into over sixty terraces each about 40 ft. high and gives the general impression of a pyramid in the process of construction. The treasure it contains amounts to some 230 million tons of iron ore which although mainly obtained by surface excavation, is also mined below ground, thus enabling production to be continued in all weathers. The average iron content is 30 per cent, a figure which is raised to over 44 per cent by roasting the ore in the neighbourhood of the workings before despatching it to the blast furnaces. Because of its low sulphur and phosphorus content this ore is comparable with the best iron ore of Sweden.

At Donawitz the ore is charged into the blast furnaces together with coke, which is either imported into Austria or made from imported coal at the new coke ovens in Linz. The molten pig iron is taken straight to the open hearth steel works for refining with an admixture of scrap. The refined steel ingots are allowed to cool to the correct heat for rolling before being rolled to different shapes and sizes. The principal products of Donawitz are blooms, billets and sheet bars (for rolling and finishing in the company's subsidiary plants at Kindberg, Zeltweg, Neuberg and Krieglach), bars and sections of all kinds, reinforcing rods, wire rods, heavy plates, girders, and rails. Most of the steel is open-hearth grade and can hold its own with the open-hearth steel of any country.



Blast furnace at Donawitz, showing hoist for ore and coke

Post-War Difficulties

During the early months of the Allied occupation, among other things, Donawitz

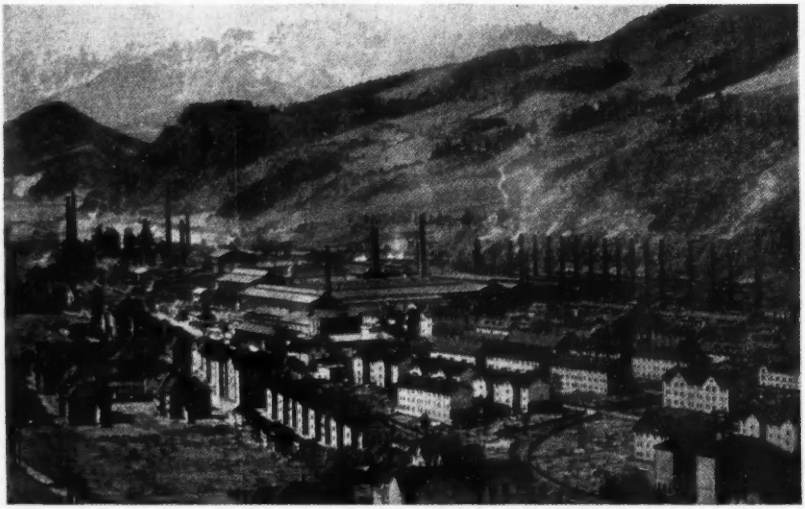
* Condensed from a Report issued by the Allied Commission for Austria.

suffered the removal of its modern electrically-driven blooming mill (through which all the steel ingots had to pass in the first stage of rolling), some of the electric steel furnaces, a large gantry crane, and a sintering plant necessary for the treatment of fine ores before they were charged into the blast furnaces. These losses, particularly that of the blooming mill, would have had a crippling effect, had not production in any case been restricted by lack of coke. However, a sixty-year-old steam-driven cogging mill was brought back from retirement, repaired with the help of Böhlers of Kapfenberg, and placed in position. A new crane was obtained from Wiener Brückenbau. In the meantime, based on reserves of cold pig iron and scrap, steel production continued on a limited scale. The old cogging mill was ready for service by the beginning of 1946, and increased steel production now became possible, although the reserves of pig iron were not unlimited.

In the absence of molten pig iron supplies, much fuel was wasted in the open-hearth furnaces by producing entirely from cold metal charges; this practice had to be continued until one of the blast furnaces could be reblown. This resulted in a monthly pig iron production of about 13,000 tons and enabled the works to double its steel output and greatly to reduce the cost of steel manufacture, for not only was there now hot metal for the steel works but also supplies of blast furnace gas, which could be used for steam-raising and for driving turbo-blowers, generators and gas-driven electricity generators.

During the early weeks of the recent power crisis Donawitz escaped from the industrial shut-down because it produced much of its own electricity, while its largest mill, a veteran of the 80's, was steam driven and thus able to operate under conditions that would have put the modern cogging mill out of action. As the fuel and power crisis grew more acute and more widespread, however, it affected almost every sphere of Austrian activity, until even Donawitz had to suffer. Early in 1947 the blast furnace had to be damped down owing to shortage of coke. This was a cruel blow to Austrian recovery. Despite the seriousness of the situation, however, the best was made of a bad job. Although pig iron production ceased completely during this period, steel production went on at a higher level than the equivalent period of 1946. But the darkest days of crisis restrictions are over for Donawitz, and not only is the blast furnace working fully but there are hopes of blowing in a second furnace. If this can be achieved Donawitz may be able to produce as much steel as it did in 1937, with all the corresponding benefit that that entails for Austrian industry and Austrian export trade generally.

The history of the Donawitz plant, and the industries based on the Styrian ore before it, is both romantic and instructive.



General view of Donawitz works.

The ease of mining and the good quality of the Erzberg ore, coupled with abundant supplies of charcoal from the local forests and the many and fast-running streams and rivers to create blast and to operate forging hammers and wire drawing mills, in ancient times combined to establish Styria as a high-grade iron and steel producing area. In the valley of the turbulent Vordernberger Bach near Donawitz, iron smelting was already well established by the twelfth century. The remains of the old charcoal blast furnaces, universally in use until the early days of the industrial revolution, are still to be seen in the Vordernberger valley and around Hieflau on the other side of the great Ore Mountain. With their turreted towers, these old charcoal furnaces look more like dis-used Baptist chapels than the remains of early iron works, and some of them indeed, are preserved as ancient monuments and for students of early metallurgy.

Monuments of Nature

It is a far cry from these picturesque relics to the great Donawitz plant of to-day which, with its long array of tall chimneys, its clusters of huge vertical cylinders, domes and inclined hoists, stands grouped as a massive monument to man's labours within the even greater monuments of Nature's mountains which surround it. The Alpine Montangesellschaft concern was founded in 1881, absorbing and modernising a number of smaller concerns in Donawitz and nearby towns. Pig iron production dates from the early 90's when the construction of the rack railway from the Ore Mountain had made it worth while erecting coke blast furnaces. From then until the collapse of the 1914-18 War the works steadily expanded. The main effect of the break-up of the Austro-Hungarian Empire on Donawitz (apart from more difficult access to many of its markets) was that it was cut off from the normal coke supplies, henceforth controlled by the reborn Poland. In the 'twenties and the early 'thirties the works went through difficult days. It went first into Italian and then into German ownership, being eventually absorbed into the Stinnes concern, which was itself taken over by the Vereinigte Stahlwerke of Düsseldorf (under which ownership it enjoyed the great advantage of coke supplies from the parent combine's own ovens in the Ruhr).

Donawitz under the Germans

Though badly hit by the economic crisis of the early 'thirties, it was doing profitable business just before the Anschluss, but the German invasion meant for Donawitz, as for the whole of Austria's industry, an over-ambitious expansion programme designed to feed the German war machine. Donawitz was forcibly transferred to the newly formed Hermann Göring Combine, which was less interested in the plant than in the development of the Styrian Ore Mountain itself. The intention was to erect an enormous integrated iron and steelworks at Linz having an annual capacity of two million tons of pig iron and the same amount of basic Bessemer and open-hearth steel and producing its own coke. The output of Styrian ore was to have been greatly increased for consumption with low grade Bavarian ore at Linz. The Linz iron and steel works were not intended primarily to produce armament steel, but to take advantage of their location on the Danube to develop the south-east European market as part of Germany's extended Lebensraum. The great disadvantage of the project was that Linz was remote both from coal and ore, both of which are costly to transport. The rapid overrunning by Germany of Alsace-Lorraine, with its vast ore deposits and many iron and steelworks, made the Linz project redundant, and construction ceased with the completion of half the originally-planned coke oven and blast furnace capacity, and a small steel works and plate mill forming part of the adjacent engineering plant.

Austria's Centre of Gravity

It would cost millions of pounds to complete the Linz iron and steel works and mills as a properly integrated unit and no amount of expenditure will ever overcome the disadvantage of its location. There is little ground for believing, therefore, that the centre of gravity of Austria's steel and iron industry will be materially changed, particularly as under modern conditions of fuel economy, it is more profitable for the plants to be located near the ore than the coal. A recently signed agreement with Sweden is intended to supply Linz with sufficient Polish coking coal to relight a further battery of coke ovens as well as one of the Linz blast furnaces, and to resume the production of steel and to increase the production of synthetic nitrogen. Austria is to pay Sweden in the form of metallurgical products.

Donawitz To-day

To bring the history up to date, Alpine Montangesellschaft, in common with Linz, Böhlers and other important undertakings, was officially nationalised last summer. Opinions may differ as to whether this is sound economics, but nobody will disagree that Austria's iron and steel industry, and the Alpine Montangesellschaft in particular, with its undertakings in brown-coal production, are vital to national reconstruction. Donawitz and the great Ore Mountain which feeds it, represent one of the greatest of all Austria's industrial assets, and one that is not necessarily thwarted by the temporary phenomenon of occupation.

A Review of F.I.A.T. Final Report No. 879

The Peeling of Nickel Deposits

THIS report has been prepared by a German consulting engineer, E. R. Thews, and contains a considerable amount of useful information regarding the causes of peeling of electro-deposited nickel coatings and the various means of correcting the faults connected with this subject. Although the report comprises only 28 pages, including a list of relevant literature, the matter is dealt with in considerable detail.

When iron or steel surfaces are pickled with acidic solutions, the process liberates hydrogen gas which adheres to the metal forming an alloy. The presence of this alloy is responsible for the condition known as pickling brittleness. Not only is the degree of adhesion of an electro-deposited coating reduced by this effect, but in time the hydrogen is gradually released from the surface and adhesion between coating and base further deteriorates, producing the well-known phenomenon of peeling and flaking. To counteract this it is necessary to reduce hydrogen absorption by agitating the articles during the pickling process. Faulty degreasing of the metallic base often prevents satisfactory adhesion of the nickel plating and it is advisable for several degreasing treatments, using different solvents and processes, to be used in order to remove the last traces of grease.

Metallic impurity is an important factor when dealing with nickel plating problems. Small quantities of iron should not affect the nickel coating provided that the electrolyte is maintained at the correct *p*H value; the optimum *p*H suggested by Thews is 5.8 to 6.0. It has occassionally been noted that if the *p*H is such that basic iron salts are precipitated in the electrolyte, these may drift to the cathode causing non-metallic occlusions. When metallic iron is present to the extent of 1 per cent to 1.5 per cent or more, the nickel deposit tends to be more brittle than an iron-free nickel plating, but this can be counteracted by the addition of a compound which forms a complex with the iron, *e.g.*, citric acid or tartaric acid. Other details are also given in the report concerning the removal of iron compounds from the electrolyte.

Zinc Affects Adhesion

Although zinc is not normally present in the modern electrolytes used for nickel plating, it should be noted that this impurity can cause coatings to have a comparatively low degree of adhesion and a dark streaked appearance. The usual methods of removing zinc are discussed in adequate detail. Cadmium is sometimes added as a brightening agent for the nickel plate but the author stresses that the quantity used should be small in order to avoid producing an unsatisfactory appearance and short life in the coating. The gloss of nickel deposits can be increased by adding a small proportion of chromic acid to the plating bath, but even a small concentration (of the order of 0.002 oz. per gallon of solution) of this material can produce hard and brittle coatings. If the electrolyte is buffered with ammonium sulphate, however, the solution is less sensitive to the presence of chromium.

Inclusion of Organic Acids

Modern baths usually incorporate organic acids such as citric, acetic, or tartaric acids, etc., although this has the disadvantage of producing internal stresses within the coating. This phenomenon can be of considerable importance as it may cause changes in the degree of hardness and adhesion and produce brittleness. The quantity of organic acid added to the electrolyte depends to a large extent on the electrolytic conditions as well as the composition of the electro-plating solution. Slight excesses of organic acids can usually be eliminated by heating with hydrogen peroxide, ammonium persulphate, etc., depending on the acid used. A slightly excessive acid concentration can also be counteracted by the use of a normal buffering agent such as boric acid. Generally speaking the exact *p*H value of the solution depends as much on the impurities present in the bath as on the nickel itself.

Organic impurities may be present in the vats used for electrolytic work especially if birch, white wood, or deal has been used for their construction. These impurities must be removed by processes which vary according to the nature of the materials it is desired to eliminate; some are oxidised by hydrogen peroxide, others are absorbed by hydrated manganese dioxide, and certain impurities can be precipitated on scrap nickel cathodes by electrolysis. The advantage of using potassium permanganate as an oxidising agent, any excess of this reagent being removed by hydrogen peroxide, is fully discussed; the difficulties of using this technique are well known to all experienced in the art.

If there is an excessive concentration of nickel salts in the electrolyte a tendency to peel may often be apparent in the nickel deposit. Pores may also develop and the appearance of the coating is often dull. The disadvantages of using a hydrometer for calculating the concentration of nickel in

(*Continued on page 332*)

METAL-TO-METAL ADHESIVES

A WIDE range of industrial uses for thin metals has been made possible by a new development in the bonding of metal to metal by resin adhesives. Diversified industrial uses can be expected in the field of thin metals where neither welding nor riveting give the desired results.

While welding and riveting metals together are well-known techniques and have been widely used, they find their most efficient application in metals of substantial thickness. More recently attention has been directed to thin sheets of lightweight metals in aircraft construction. When used with such thin metals, rivets tend to cause stress concentrations, create uneven surfaces that impede free air flow, add appreciable weight when every added pound cuts down the speed, and produce weak joints; while welding thin metals is at best a difficult technique, accompanied by many variable hazards.

Until very recently complete and continuous adhesion between contacting metal surfaces was largely wishful thinking. Neither the materials nor the technique had reached a stage of development where industry could utilise them economically. The need for simpler methods of bonding metals was further emphasised by the tremendous requirements of the war effort. As a result, concentrated research was directed toward adhesives that would produce metal-to-metal joints of maximum strength and durability.

The underlying principles of adhesion are not, as yet, well understood, and the advent of resin adhesives during the last decade has emphasised the need of more fundamental knowledge in this direction. An excellent summary of the situation, prepared by the U.S. Bureau of Standards, has been made available recently and contains an extensive bibliography on all phases of the subject for those who wish to investigate further.

Official Recognition Rare

Many types of metal-to-metal adhesives have been explored, some advanced enough to be given a trade name but only a very few have gained the recognition of government authorities by being given exhaustive examination for military equipment. One of these is a phenolic type applied as a liquid plus a powder, and cured under substantial heat. It is an adhesive of the phenol formaldehyde type and its durability is of the same class as the phenolics.

Most of the other metal-to-metal adhesives are proprietary products and their composition is known only in general terms. Most of them have substantial ratios of natural or artificial rubber which has good adhesive qualities with the metals. So far as is known all require the application of heat and pressure to secure a durable bond, and thin glue lines are important. Where rubber is a substantial component, the durability is usually somewhat lower in the scale than with the phenolics. There is little published data on their serviceability under severe service exposures. Hence the durability characteristics that are given here are the results of tests by government agencies, as well as by industrial organisations.

U.K.-Developed—U.S.-Produced

This metal-to-metal adhesive was developed by a British firm. Its production, however, was undertaken in the United States. The development of the adhesive resulted from a need for joining thin metal sheets with maximum smoothness for aerodynamic purposes, without the irregularities that result from riveting, or the heat distortion that usually accompanies welding. The first development work was in the aluminium alloys. The process is based on the use of two separate components, a liquid and a powder.

It is of the utmost importance that metal surfaces are thoroughly cleansed and freed from oil or grease immediately before the liquid is applied. A slightly roughened, rather than a smooth or polished metal surface is desirable for strong, durable joints. A simple test for an adequately cleaned metal surface is to flow water over the surface where it should form a continuous and unbroken film. The liquid is applied to the clean metal surfaces, by spray, brush or roller coating. Immediately after applying the liquid, the powder is sifted on the wet surface, enough to cover it entirely, and any surplus removed by light tapping.

The powdered surfaces are allowed to dry in order to permit solvent evaporation. For small areas 5 minutes may be found adequate, but for substantial areas 30 to 60 minutes is a safer basis to eliminate the hazard of steam blisters. Periods from 8 to 24 hours are permissible, and in some cases several days can be allowed. After the solvent has dried, the two coated surfaces are placed together, taped to maintain proper alignment, and pressed between steam-heated platens. During the bonding operation the adhesive first goes through a stage of plastic flow, during which the two components become intimately mixed, and then fuses to the metal surfaces, resulting in a strong, durable bond.

Metal-to-metal adhesives, so far, have been chiefly used in lap joints, in lieu of rivets or spot welds. The extent of distortion, or eccentricity is materially influenced

(*Continued on page* 332)

ELECTROLYTIC LEAD (*Contd. from p.* 326)

so that it is crystal clear at all times. To ensure perfectly smooth dense deposits, a drop of clove oil is supplied to each tank, which simplifies the work. Although current densities can be much greater than formerly, it is more frequently restricted to 16 amps per sq. ft. Voltage commences at 0.35 and gradually increases as the electrolysis proceeds to 0.44 volt, but if the slime blanket is properly prevented from forming on the anodes by good working of the filter, it should not rise beyond the 0.40 volt limit, and further increases are often only due to resistances.

Variations of Physical Characteristics

The pure lead obtained by this method differs quite materially from ordinary electrolytic lead, and it has a tendency to form large crystals, the difference of which can sometimes be clearly portrayed by magnifying glass, without necessitating regular microscopical examination. Hardness as tested by the Brinell method is reduced from 4.2 to 3, elongation is increased from 64 per cent to 69 per cent, but tensile strength is reduced from 1.960 lb. per sq. in. to 1.600 lb. per sq. in. The manner in which this pure lead stretched under different conditions of heating and cooling made necessary the introduction of apparatus specially designed for making these examinations. Exacting tests revealed that although all ordinary forms of lead showed but little change in specific gravity on annealing, perfectly pure lead altered from 11.35 to 11.31. When tested chemically, it was found less easily corroded than other leads, particularly with sulphuric acid, and attracted a certain amount of attention in telephone researches even prior to the war. The matter of plastic flow showed that whereas ordinary electrolytically refined lead revealed little tendency to alter its size, creeping appeared with the perfectly pure metal. While under continuous load, and after repeated heating and cooling, the pure material permanently increased its length from 0.4 per cent to as much as 1.25 per cent, depending on the weight applied.

Ordinary chemical lead, on the contrary, either remained unchanged, or diminished in size by 0.5 per cent. Although these variations might appear to be somewhat small, it has to be remembered that in all nuclear researches so far undertaken, only the purest obtainable materials can be considered.

Increasing Wolfram Output in Spain.—The conclusion of a trade agreement between Spain and Italy, which provides, *inter alia*, for the shipment of 530 tons of Spanish wolfram, has lead to an increasing output and firmer prices.

NICKEL DEPOSITS (*Continued from page* 330)

solution is emphasised and at the same time the value of chemical methods of analysis are stressed. Salts such as sodium chloride may occasionally be added to the nickel solution in order to reduce the electrical resistance of the electrolyte. This salt also exerts a considerable effect on the solubility of the nickel and, if used in too strong a concentration, will alter the nature of the electrolytic deposit. At the same time the disadvantage of not using conduction salts is instanced by the comparatively slow deposition of nickel and a tendency towards unsatisfactory appearance in the resultant film. Cyanide should not be present in the bath as this will cause the nickel deposit to flake. Many troubles are also associated with high current densities and the optimum values must be determined for each type of bath used.

This report also deals with the deposition of nickel on other metallic compounds and discusses the effects of excessive polishing. At the end of the report there is an extremely interesting summary of the various faults which may occur in nickel plating together with a useful list of the possible causes of each phenomenon.

This report is issued with the usual warning regarding the possible infringement of existing patent rights.

METAL ADHESIVES (*Continued from p.* 331)

by the thickness of the metal and the length of the overlap. The simplest form of lap is the plain square end overlap. It might be expected that a lap 1 in. long would be twice as strong, in shear, as a lap ½ in. long, but such is not the case. The disturbing influence is the elasticity of the metal, together with the distortion noted above, which causes greater stresses at the extremeties of the lap than at its centre. It has been determined that the strength of the metal-to-metal lap joint varies directly as the width.

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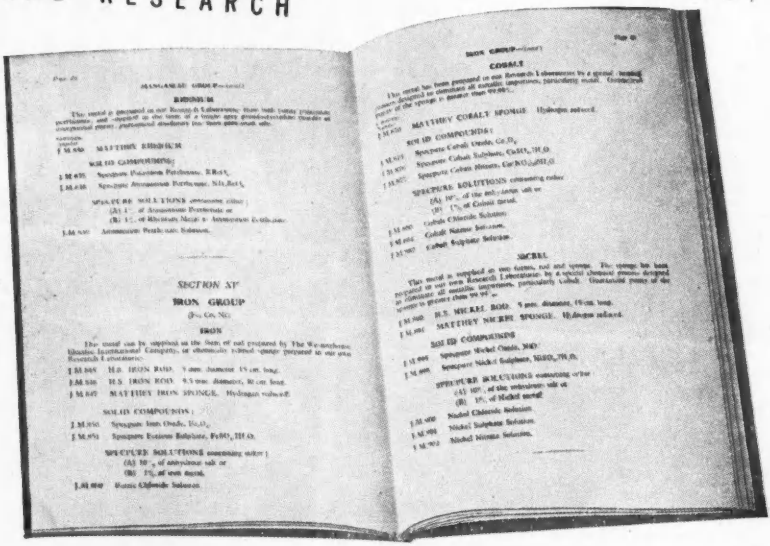

SECTION XV

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IRON

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MATTHEY COBALT SPONGE. Hydrogen reduced.

SOLID COMPOUNDS:

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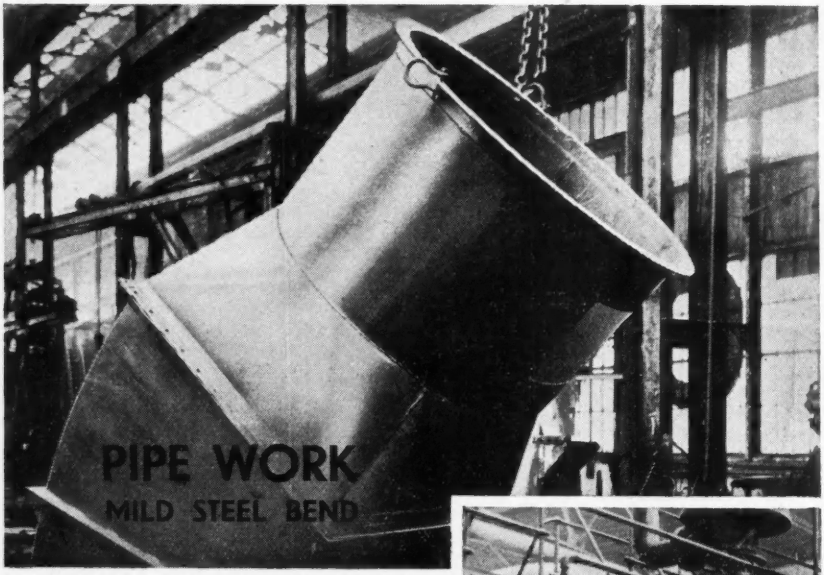
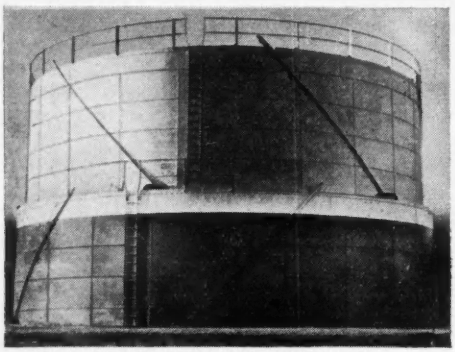
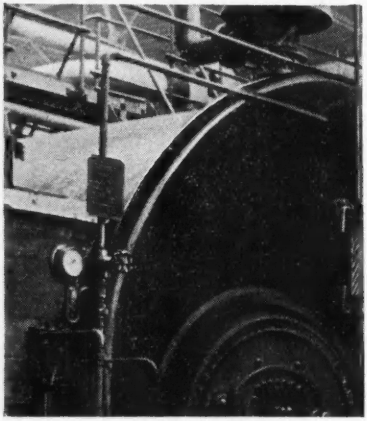




SPIRAL GUIDED GASHOLDER—AUSTRALASIA



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Metallurgical Section

4 October 1947

WASTE PICKLE CONVERSION TO NEW MATERIAL

by WILLIAM BULL

THE processing of steel plant spent acid pickling liquor in order to secure concurrently economic and innocuous disposal presents a renewed challenge to metallurgical ingenuity, especially at these times when industrial efficiency is the only effective counter to cumulative national stringency. Most of the disposal methods involving conversion into commercial products, such as oxide pigments and polishing compounds, copperas, or chlorinated copperas for treatment of water or as a flocculating agency in sewage disposal, are handicapped through relatively restricted markets.

Certain other disposal methods involving chemical reaction with coke gas products, including ammonium sulphate, iron hydroxide, sulphide or carbonate, which prior to 1939 were receiving parallel attention in Britain and on the Ruhr, are in a different category as their manufacture involves costly specialisation in plant and carefully controlled processing. The regenerative processes whereby ferrous sulphate mixed with pulverised low volatile coal (I.G. Farbenindustrie or Clarkson-Fersul process) where through catalysis and controlled temperature iron oxide plus sulphur trioxide is utilised for production of sulphuric acid and smelting oxide are also in a different class economically. The capital costs involved predicate continuous operation and large-scale production.

Urgency of building, rebuilding and conversion within the United Kingdom lends special interest to a sulphuric (or hydrochloric) pickle liquor disposal method developed recently by which a cellular insulating building construction material is produced. The material, named "Ferron," can be produced at the rate of five tons dry product for each ton quicklime, which is the only significant raw material required in processing dilute spent pickling liquors or acid wash liquors. This method is in commercial scale operation at the Sharon Steel Corporation Plant, Pennsylvania. The Corporation was the first company to adopt the process and owing to satisfactory results the scale of production has been progressively increased to plant capacity, and the writer is indebted to Mr. C. W. Weesner, consulting metallurgical engineer to the Corporation, for details of its working and economy. The material is being dispatched from the Sharon Plant to consumers for purposes ranging from boiler and thermal service insulation, domestic and general building construction or sound proofing, and as a clarifying agent for hydrocarbon solvents and lubricating oils. Calculations, which apply to the U.S.A., indicate that a field for around 7500 tons daily output exists. Undoubtedly, if steel companies in the United Kingdom disposed of their surplus pickling liquors under this system the tonnage output would assume very important proportions in shape of fireproof, cellular wallboard, hollow tiles and lighter-than-clay products, raw moulding material for switchboards, insulating material for refrigeration plant or ship interior material at a favourable cost relative to present high costs of standard building materials.

Ferron is relatively inert, non-corrosive and combines 50 per cent air pores or air cavity constitution; it lends itself excellently to working by ordinary tools, takes wood screws or nails with facility; the material is not friable nor easily damaged during building work, and it may be waterproofed with sodium silicate or by coating with a varnish. It allies itself satisfactorily to cement or concrete. Results at Sharon are with pickle liquor at 26 per cent $FeSO_4 + 7\,H_2O$ and 6 per cent H_2SO_4, that is, 5.3 per cent iron and 6 per cent acid = 37 lb. of Ferron from 10 gallons pickle; this according to a simple working formula used by the company and expressed as "the amount of Ferron in pounds that 10 gallons of this pickle liquor will make equals the per cent acid by weight times 1.75, plus the per cent iron by weight times five."

What is new about the process is not primarily the lime-liquor reaction, which is $FeSO_4 + H_2SO_4 + nH_2O + 2Ca(OH)_2 \rightarrow 2CaSO_4 2H_2O + Fe(OH)_2 + (n-2)H_2O$,

but the mechanical and thermal processing leading to creation of a utilisable raw material. The process at Sharon has been modified, in the light of progressive production, from a batch process to more or less continuous production by automatic precipitators, continuous driers and so forth, and the main charges are for quick-lime at the rate of one ton per five tons dry Ferron and fuel costs, for gas in this case, for tunnel drying operations.

Movement of Liquor

From the main pickle reservoir with a capacity of several days' production release, the liquor is pumped into 2000-gallon agitating tanks and there processed with milk of lime. The crushed rock quicklime is moved by auto-hoist from rail trucks into an elevated steel bin and thence by gravity feed to a 1500-gallon mixing tank for slaking. The pickle is added to the agitator tanks, together with small amounts of fibrous material—pulped newsprint, for instance—and the mix is diluted to a point where iron sulphate is 5 per cent and acid content 2 per cent, a dilution essential for securing satisfactory reaction and acid wash water may be added to depress strength without disadvantage. Milk of lime is added during agitation up to complete neutralisation point, precipitation of iron then being complete in form of hydroxide. At this processing point a quick rise in *p*H is denoted and checked by contacting a slurry sample with phenolphthalein-moistened paper, bright red colour denoting completion of reaction.

Final Processes

The agitated slurry is now pumped, via plunger type pumps, to pressure filters. The slurry readily pumps and filters, but high pressure is necessary to secure reduction of moisture content to around 50 per cent. The firm consistency press-cakes then resulting are fed through a clay pug mill, the pounded mass being subsequently extruded on to travelling steel trays. The loaded trays, racked three deep, are processed through a gas-heated tunnel drier. Here the 50 per cent residual moisture is evaporated, the material sets and oxidises, forming a product of high porosity. Total production costs, including labour and power, are estimated at around £1 per ton of product, this representing disposal of 500 gallons spent pickle.

The following comparative figures for insulating properties of the resultant Ferron are expressed as B.Th.U. per hour per sq. ft., 1 in. thickness and in degrees Fahrenheit:—

Materials	
Ferron	.55
Asbestos sheet	1.05
Building brick	4.80
Fireclay brick	8.40
Plaster	3.00
Gypsum (made up)	3.00
Cork	.30
85 per cent Magnesia insulation	.47
Concrete	5.28
Breeze concrete	2.40
White pine timber	1.04

Ferron will withstand temperatures up to 900° F. and when admixed with clay to 50 per cent up to 2000° F., considerably above organic insulating material levels. Its insulating capacity is estimated to be 5½ times greater than standard plaster or gypsum-rock building wall-board and is 2 to 1 favourable in comparison with average timber. The residual effluent, by analysis, possesses no oxygen absorptive character and it will increase *p*H of streams at discharge site; its contents are calcium hydroxide, calcium sulphate and sodium chloride, in that order. The water is, however, too hard for use in plant.

Dilution of Liquor

Further details of practical interest denote that the conjoint precipitation of calcium sulphate and ferrous hydroxide produce a composition termed "ferroxy-calcium sulphate" of a character distinct from its separate components. It is said that, in practice, a very wide dilution of liquor is permissible as long as the ratio of precipitate is 10 per cent ferrous hydroxide, remainder being calcium sulphate, and that conditions will vary in individual steel plants without affecting final results, if controlled according to whether the processing is by continuous pickling of strip with up to 7 per cent acid, whether stainless or alloy steels are processed, or on quantity of acid wash water for disposal. Ferron may be satisfactorily precipitated at atmospheric temperature, but is more complete at 70° C. Cost of the installation at Sharon was around £23,000 and the Ferron product is saleable as non-hygroscopic wall-boards, or building construction panels at $10.00 per thousand board feet.

The experience of Mr. R. J. Wean, president, Wean Engineering Co., Inc., the company mainly responsible for construction of Ferron plants, is that unit requirements vary among steel plants, that power consumption at filter press location is relatively heavy and that improvements are in hand on this problem. The aim is to make standard unit plants, and blueprints have been made of standardised designs to handle 5000, 10,000 and 50,000 gallons daily.

USE OF SPONGE IRON IN STEEL PRODUCTION

Report of Investigations

A 74-page report by the United States Bureau of Mines, richly furnished with data, figures, tables and references, on the use of sponge iron in steel production has just been released.

The investigators come to the conclusion that sponge iron can be used to replace a portion of the scrap iron normally employed in the production of steel. The maximum percentage of sponge iron that can be substituted without requiring an appreciable change in furnace operation or without reducing furnace capacity depends on the grade of the sponge iron, the type of furnace employed, and the operating procedure.

The physical properties of steel made with some sponge iron in the furnace charge were as good as those of steel made with normal raw materials. They were processed without difficulties by the usual procedures.

Oxidation During Storage

It was found that sponge iron oxidises readily when stored outdoors for extended periods during rainy weather. The tests demonstrated that such oxidation interferes with the effective utilisation of sponge iron as a melting stock in steel production. Consequently it should preferably be used within a few days after receipt or stored under cover.

Well-produced sponge iron in the form of slabs with low sulphur (0.014 per cent), phosphorus (0.008 per cent), and silica (1.5 per cent) contents was found to be very satisfactory when used to the extent of 50 per cent of the charge in electric furnaces making high quality steel.

Sponge iron with a relatively high silicon content (6.5 to 7 per cent) made from blast furnace grade ore without a special concentration was used as 25 per cent of the furnace charge at one plant and 32 per cent at another. The heats were satisfactory, but the slag volume was abnormally large because of the high gangue content of the sponge iron. Both the plants employed a two-slag practice; that is, the oxidising slag was removed after melt-down and then constituents were added to form the reducing slag. When this grade of high-silicon sponge iron was used with single-slag practice, it appeared that about 15 per cent sponge iron in the charge was the maximum amount that would give satisfactory operation.

Granular sponge iron was used as 18 per cent of the furnace charge at one plant. The only difficulty experienced was the sticking of a small amount of the sponge iron to the walls. If the granular sponge iron is loaded so that it is in the centre of the charge, it should be a satisfactory raw material for basic electric furnaces. Granular sponge iron has a low density, but if properly charged it would flow into the voids between scrap and, therefore, the use of moderate percentage of granular sponge iron should decrease the volume occupied by a furnace charge. At some plants the use of granular sponge iron might avoid the necessity for charging more than once and thereby possibly decrease the operating time.

Acid electric furnaces are generally used in the production of steel castings for which it is often desirable to have metal low in sulphur and phosphorus, but neither of these elements is removed with an acid slag. Therefore the investigators were interested in the possibility of producing castings with low sulphur and phosphorus content by using sponge iron as a portion of the charge. For sponge iron to be a desirable melting stock for acid electric furnaces, it should be low in sulphur and phosphorus (below 0.02 per cent for each element). Data on only a few tests were obtained in acid electric furnaces, for which sponge iron constituted one-quarter to one-half of the charge. In these tests, reactions between the iron oxide of the sponge iron and the carbon in the bath appeared to cause more trouble than in basic electric furnace tests, indicating the need for a well-reduced sponge iron in acid electric practice. However, this difficulty could possibly be overcome through the development of the proper charge composition and loading procedure. In these tests the slag volume was somewhat greater than for normal operation. This caused no trouble in the furnace but was undesirable in the ladle during the casting operations. This disadvantage could probably be overcome through a change in the operating procedure, such as the removal of part of the slag during the progress of the heat.

Sponge Iron Slabs

Sponge iron slabs with a high silicon content (about 7 per cent) were used to replace scrap in a basic open-hearth charge to the extent of about 12 per cent of a cold-metal furnace charge without any appreciable change in operating procedure or reduction in furnace capacity. No tests were made with a higher percentage of sponge iron of

this grade, as an excessive slag volume would have resulted from the high silicon content of the sponge iron.

Sponge iron slabs made from mill scale with a lower silicon content (2 to 3 per cent) were used to replace scrap to the extent of 20 per cent of the furnace charge. These heats melted lower in carbon than the regular heats at the plant, which indicates that the proportion of pig iron or carbonaceous material in the charge should be increased over that normally employed. In other respects, this percentage of sponge iron in the furnace charge caused no operating difficulties. From the furnace tests it would appear that the slabs of sponge iron should preferably be charged on top of scrap and then covered with additional scrap to prevent oxidation of the sponge iron by exposure to the heating flame.

Sponge iron made in the form of dense pellets in a rotary kiln was used as half of an open-hearth charge. The pellets were placed in piles on the bottom of the furnace, followed by hot metal after apparent fusion of the sponge iron. The heat required two hours longer than for normal operation, so it would appear that only superficial fusion of the pellets had occurred prior to the hot-metal addition. A change in operating procedure, such as the use of smaller amounts of sponge iron charged on top of scrap, would probably give more satisfactory results.

High-Quality Sponge

A high-quality sponge iron was used successfully as 20 per cent of an acid open-hearth charge at another plant. Sponge iron with a relatively high silicon content (6.5 per cent) was employed as 13 per cent of an open-hearth charge without interfering with normal operation. However, the carbon and silicon content of the furnace charge should be increased above that used in normal operation to compensate for the iron oxide present in the sponge iron because of incomplete reduction and oxidation during melting. The reaction was generally favourable to the use of sponge iron low in sulphur and phosphorus.

The report points out that sponge iron processes warrant consideration as a means of alleviating a scrap shortage during a war or other national emergency. It can be made with equipment constructed for other purposes (brick plants, cement kilns), and therefore production could begin in a short time with only a small expenditure for minor changes in plant facilities. Possible higher production cost for sponge iron processes operating on a small scale, compard with blast furnaces, might be offset by the high cost and time required for new blast furnace construction.

The economic use of sponge iron as a raw material for general steel production in normal years depends on the development of processes for producing this material on a large scale at low cost. Such processes would appear most applicable to sections of the country that do not have coking coals suitable for blast furnaces but do have ores and reducing agents satisfactory for sponge iron production. In the present stage of development of sponge iron processes, it appears economically feasible to produce a high-purity material on a relatively small scale for use in the manufacture of special steels in electric furnaces.

Chrome Ore and Concentrates

The Ministry of Supply announces that new selling prices for chrome ore (see table below) which include carriage charges to nearest rail point consumers' works, are to apply as from October 1, 1947. The prices are an increase of 2s. per ton ex ship, and 4s. per ton ex store, with the exception of the prices of the Turkish ores which are new importations into Britain.

Grades	Per ton ex ship £ s. d.	Per ton ex store £ s. d.
Refractory:		
Rhodesian imperial grade	9 14 6	10 14 0
Transvaal 1st grade ...	7 19 6	8 19 0
Sierra Leone	9 12 0	10 11 6
Phillippine	8 12 0	9 11 6
Indian...	9 4 6	10 4 0
Turkish "A" grade ...	9 14 6	10 14 0
Turkish (grade 1)	9 18 6	10 18 0
Metallurgical:		
Rhodesian washed concentrates	9 17 0	10 16 6
Rhodesian lumpy metallurgical	9 17 0	10 16 6
Baluchistan	10 2 0	11 1 6
Chemical:		
Rhodesian dyke chemical	9 17 0	10 16 6
Transvaal chemical XL concentrates	9 19 6	10 19 0
Transvaal "A" grade concentrates	9 9 6	10 9 0
Baluchistan	10 2 0	11 1 6
Indian...	9 19 6	10 19 0

Low Melting Alloy

Instead of waiting from six to eight weeks for small experimental steel dies to be made, research engineers of the Ford Motor Company have developed a new alloy which speeds the production of their experimental dies. This metal, an alloy of bismuth, tin and lead, is ordinarily too soft to stand the tremendous pressures imposed on dies. They have overcome this obstacle by freezing the die in liquid nitrogen, which produces a Fahrenheit temperature of 320 degrees below zero. This freezing action confers a tremendous surface hardness. From six to ten samplings can be secured between chillings in the frigid bath. Thus, instead of waiting from six to eight weeks for small steel dies, the soft metal dies are produced and sample parts obtained in 24 to 48 hours.

Oxygen Steel Production

THE technique of using oxygen is now being further developed in the steel industry to promote chemical reactions in the open-hearth process of steelmaking and to speed up the production of steel, according to a statement by the American Iron and Steel Institute.

"Oxygen is one of the commonest of all elements but its progress as a general industrial tool has been comparatively slow as against some other, rarer elements," states the Institute.

"For many years the cost of commercially pure oxygen was a barrier to its increased use. Technical papers on the possibilities of this type of oxygen in steelmaking were presented before the Institute at least as early as 1920 when several experts formerly discussed this subject. Although still in the development stage, the use of manufactured oxygen in steelmaking is far beyond the stage of experimentation. Full-scale commercial use now depends largely on the speed with which economical oxygen-producing plants can be built adjacent to steelmaking furnaces. Several oxygen-manufacturing plants are now under construction, and it is reported they will produce a gas of 90 per cent purity at about $7 per ton.

"Commercial oxygen is used in the manufacture of open hearth steel in two different ways. One use of it is to enrichen the open hearth flame to speed up the melt-down period. This use of oxygen is based on the fact that the oxygen enriched flame is hotter than the conventional flame and so reduces solid scrap and limestone to liquid metal and slag very rapidly. The flame temperature reached in ordinary open hearth practice is about 3300° F. while temperatures of 500° F. higher or more are attained by the use of oxygen, depending upon methods of use. This hotter flame is achieved with 10 to 25 per cent reduction in fuel and with little or no damage to refractory materials, inasmuch as the maximum temperature prevails for only a few minutes under present practice."

Tin Metal Allocations

The Ministry of Supply announces the following additional interim allocations (in long tons) of tin metal by the Combined Tin Committee for the second half of 1947: Ceylon, 18; Egypt, 34; Finland, 22; Ireland, 18; Palestine, 66; New Zealand, 129; Jugoslavia, 116; Australia, 150.

These allocations are additional to those announced on July 8 and 22, and on August 21.

The 29th annual National Metal Congress and Exposition will be held in Chicago for seven days beginning October 18, 1947.

Use of Sintered Ore

STEEL is lacking to-day because raw materials for charging the furnaces are in short supply. To produce ninety million tons of steel annually, U.S. manufacturers use a hundred million tons of raw materials of which 35 per cent is scrap. Twenty per cent of this comes from the fabricating plants, leaving a balance of 15 million tons a year to be acquired outside the industry. The maximum capacity of furnace production cannot be used to-day because of a shortage of scrap, and as a result, American geologists are advocating an expansion of capacity to produce sintered ore or concentrate as a way out of the difficulty.

The following are some of the advantages said to accrue from the use of sinter as a substitute. Lump ore, of whatever quantity and quality, is not necessarily indispensible to furnace charges. Scrap requirements could be halved, and sufficient supplies obtained within the steel plant itself. Large quantities of sinter could be produced in plants constructed quickly and inexpensively, and low-grade Mesabi ores could keep the steel furnaces indefinitely supplied. No drastic steel plant conversion would be necessary, since the steel industry has had long familiarity with the characteristics of Mesabi ores. Light sinter could be made for the blast furnace, and heavy sinter for the open hearth. Limestone flux could be pre-mixed with sinter feed thus obviating the time and expense of preparing blast furnace charges.

Beneficiation of the low-grade taconites—their concentrates will have to be sintered before charging to the furnace—will materially increase iron ore reserves for some time to come. The supply of the taconite is such that it is said to be capable of meeting the needs of the industry for more than 100 years, while beneficiation of these valuable ores will not only maintain America's steel production but at the same time effectively and permanently resolve scrap shortages.

Foundry Output Increase

Mr. James Ernest Smethurst, head of the firm of James Smethurst & Sons, engineers, iron and brass founders, Warrington, one of the oldest foundries in the country (established in 1785), stated that output had increased by 26 per cent during the last two months, and would have been higher but for the stoppage of coal in the early part of the year.

Employees work under the contract price system which has had beneficial results on output and, in addition, unskilled workers have been trained in plate moulding. Production would be further increased if the workers had concessions with regard to the payment of income tax and overtime, said Mr. Smethurst.

WELDING STANDARDS

THE October issue of *Welding Research*, which is published in conjunction with the *Transactions of the Institute of Welding*, will contain two papers dealing with "Recommendations for the Design, Fabrication and Erection of Metal Arc Welded Mild Steel Building Structures" and "The Photographic Aspects of the Radiography of Welded High-Pressure Vessels," by Mr. L. Mullins.

The first paper comprises recommendations prepared by the British Welding Research Association from a detailed survey of present practice. The work was undertaken with two principal objects in view: the provision, at the request of the Institution of Structural Engineers, of clauses for inclusion in the Welded Steel Construction section of the code prepared by the Institution for the Codes of Practice Committee for Civil Engineering, Public Works and Building; second, the preparation for the British Standards Institution of recommendations on which to base a revision of B.S. 538-1940, "Metal Arc Welding in Mild Steel as applied to General Building Construction."

The second paper is complementary to the "Recommendations for the Standardisation of the Radiographic Examination of Welded Joints in Mild Steel Pressure Vessels" which appeared in the journal's August issue.

GERMANY FOOD INDUSTRY

AN exhibition of photographs, drawings and specimens, obtained in Germany by B.I.O.S. investigating teams sponsored by the Ministry of Food, will be on view in the Conference Hall, Portman Court, Portman Square, W.1, from October 15 to 29, between the hours of 10 a.m. and 4 p.m.

The following are among the informal talks to be given in the exhibition at 3 p.m.: Thursday, October 16—"German Soapless Detergents," by Mr. G. R. Perdue; Wednesday, October 22—"Food Preservation and Refrigeration in Germany," by Dr. E. C. Bate-Smith.

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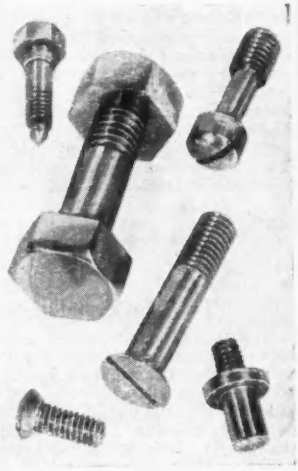

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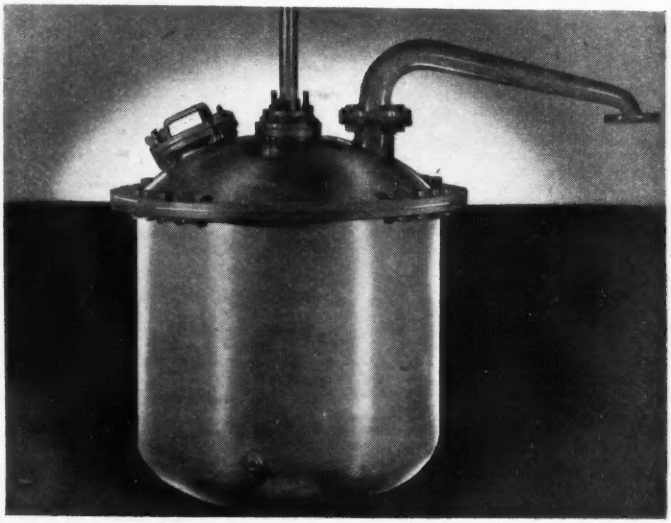

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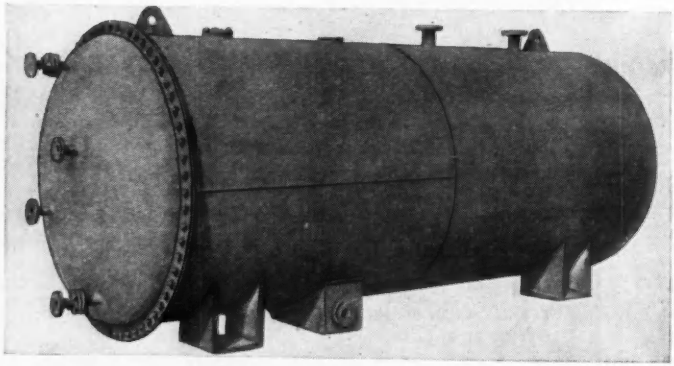


Illustration shews M.S. Rubber Lined Tank for Hydrochloric Acid

TANKS. CYLINDRICAL AND RECTANGULAR
PUMPS AND FLOW METERS, ETC.

Metallurgical Section

1 November 1947

The Fluoroscope as a Flaw Detector

Effective Substitute for Radiography

by L. SANDERSON

THERE has been a marked development of radiographic inspection of steel castings of recent years, and the expert radiographer has also been widely employed in examining light alloy castings for flaws. The value of radiographic examination is not disputed, but it should not be forgotten that the fluoroscope is an important instrument for detecting flaws in castings.

Fluoroscopic Examination

There are several patterns of commercial fluoroscopes, and it is not practicable here to describe them in detail. A brief account of one method of examination in which this instrument is used will be of more value.

The castings to be examined are placed on a series of conveyor trays carried by an endless belt through a tunnel lined with lead over a 140 kvp industrial X-ray unit or tube. The inspector is located in a dark chamber situated directly above the castings so that he can watch the screen by looking downwards at a horizontal screen above the castings. The trays are capable of controlled movement, from zero to a maximum of 20 ft. per minute, as desired.

The window through which the inspector looks is a normal 1 in. thick assembly of lead glass, treated so as to minimise reflections from the surface. The X-ray tube has a 24 mm. focal spot and functions at a voltage of 140 kvp, the tube current being 8 ma. The factors most affecting the results obtained are the thickness of maximum section of the casting, the speed of movement of the castings undergoing inspection, the space separating the X-ray tube from the bases of the conveyor trays, and the distance between screen and casting.

Vital Points

In carrying out a fluoroscopic inspection, certain vital considerations must be borne in mind. There is no golden rule which indicates the minimum dimensions of the discontinuity or blowhole, gas bubble, etc., it is desired to detect. The size of cavity that can be detected depends on the total area of metal affected, the cross section of the cast part, the rate at which the cavity diminishes in thickness towards its boundaries, and other factors not fully understood as yet.

On the whole, it is much harder to detect a defect forming a spherical cavity than one which takes the form of a long cylinder of equivalent diameter, while a cavity shaped after the fashion of a ring but of diameter equal to that of the cylinder, will be harder still to find. It appears that the sharper the edges of the image, the easier it is to see, and that images of small dimensions cannot have sharp edges by reason of the grain of the screen.

Effect of Cross Section

The heavier the cross section of the casting, the higher the degree of percentual sensitivity, and the relation between these factors is virtually proportional. Absolute sensitivity, however, declines with increase in cross section.

The best results are obtained when the focal spot of the X-ray is placed approximately 5 in. from the bottom of the trays. A decline in focal spot-screen distance over the range raises the brightness of the screen by a factor of $\left(\frac{-}{22}\right)^2 = 8.3$. As the screen brightness becomes greater, less dark adaptation is necessary for easy observation. Those portions of the casting that have not been masked do not develop a marked glare, and this fact means that complicated masking is not needed.

The Plastic Cell

The location of the X-ray tube as close as 5 in. to the tray bottoms gives a much brighter screen, and although some users still employ the lead glass window with a distance of 20 in. between tube and tray bottoms, it is considered better to dispense with the lead glass because of the rapidity with which it discolours when subjected to the action of X-rays at short distances.

Modern fluoroscopy employs instead a plastic substance known as Lucite in the form of a cell containing a virtually saturated solution of lead perchlorate. If the cell has a thickness of 3 in. of solution

it will be almost the equivalent of 1 in. of lead glass or ¼ in. of metallic lead.

These cells are not affected in any way by the rays, and both plastic material and perchlorate solution have the same refractive index, which means that they have no surface reflection between them.

Assuming that the cell thickness is a fair proportion of the entire viewing distance, there will be a foreshortening caused by the solution, and this will appear to enlarge the image by D × R, where D is a number of diameters, and R is the refractive index of the solution.

Under even the most favourable conditions, the fluoroscope cannot produce so good a result as radiography, where ultimate contrast is desired. The reason is that the X-ray film is a device for amplifying contrast, whereas the fluoroscopic screen is not. If the X-ray tube current is strengthened, there is an increase of corresponding amount in physical brightness, but the gain in contrast is relatively slight. In consequence, no benefit appears to be derived from employment of the considerably more expensive X-ray tube equipment required for work at a tube voltage of 160 kvp and a tube current of 15 ma. (representing a doubling of the current).

In fact, it is not possible to make the screen bright enough by increasing the tube current, the reason being the heavy power consumption required and the equivalent amount of heat to be dispelled at the target. Moreover, if the tube current is intensified, it will be neccessary to increase the dimensions of the focal spot.

The Short Distance Tube

It follows, therefore, that to bring the distance between tube and tray bottoms down to about 5 in. with the employment of a higher voltage is the sole practicable means of developing adequate screen brightness with the equipment purchaseable to-day. It has been suggested that a higher voltage than 150 kvp might be advantageous, but no experimental proof of this has yet been obtained, and experts are inclined to doubt whether it would make the screen brighter, at all events in thin sections, though with heavier sections there might be an improvement. Another suggestion is that the screens should be sensitised for increased efficiency at higher voltages, but so far no experiments in this direction have been carried out.

We have seen that the primary purpose of locating the tube close to the tray bottoms is to give a brighter screen, but the procedure has its disadvantages.

In the first place, the field of view is less extensive, which means that the distance between tray and focal spot cannot be reduced below 5 in. save when extremely small cast parts are being examined. Assuming the screen to be approximately 3 in. above the tray bottoms—and it is always desirable that it should be as near as possible, without risk of its being fouled by the moving castings—the field on the screen will have a diameter of approximately 7 in., with one side diminished by the shadow of the target. Certain types of castings need a larger distance between object and screen if the object is not to foul the latter. The result of this increased screen distance is a larger apparent field of view.

Secondly, those flaws not near to the screen have extremely blurred shadows by reason of the dimensions of the focal spot, and if the spot employed exceeds 2.4 mm., this effect is even worse. On the other hand, it does not necessarily hinder the inspector from perceiving a flaw, but it makes it difficult for him to see details at the boundaries, and therefore he may not be able to decide whether the flaw he detects is a gas hole or a slag pocket. For this reason it is often advantageous to turn the part over for a further inspection.

Detection of Defects

A second advantage of short focal spot object distance is worthy of note. If the cast part makes only a slight movement in relation to the focal spot of the tube, it sets up a considerable rotational distortion effect on the object shadow, and this, while not impeding the observer, helps him, as it happens, to perceive a number of flaws that would otherwise escape his notice.

Flaws concealed by ribs, lugs, and other heavier sections can become perceptible as a result of the apparent change in location or rotation of the part. The movement of the trays in relation to the tube causes rotational scanning in one direction. Scanning at right angles to the tray movement is facilitated by placing the X-ray tube on a rack. This enables it to be moved 6 in. Defects have been perceived in this way that were not detected even by a radiograph taken in several directions.

Limitations of the Fluoroscope

It must be recognised that the fluoroscope will not reveal an extremely large number of small flaws capable of perception on the radiographs, but if rotational scanning is employed, a remarkably large number of medium and bigger flaws are revealed that do not show up on the radiographs. How far the fluoroscope can be employed, therefore, depends on the distinction drawn between flaws liable to cause rejection and those that can pass the inspector. Much work has still to be done, and the instrument has been primarily employed, up to now, in the examination of light alloy castings. Some most valuable work has been carried out by the California Institute of Technology in this connection.

IRON SULPHATE RECOVERY

German Practice Reviewed

PROCESSES employed in Germany for recovering iron sulphate from spent pickling liquors have been described in a report just released by the office of Technical Services of the U.S. Department of Commerce. Besides recovering the iron sulphate, the processes check pollution of streams and public water supplies and improve the pickling operation itself.

Although developed primarily to check stream and water supply pollution and recover iron sulphate, the processes are said to give more uniform results in pickling operations, and require less supervision. Above certain concentrations, the iron sulphate acts as a pickling inhibitor, so that smaller quantities of other inhibitors need be used. Information on equipment and labour required, 11 drawings illustrating machinery and other operational data are included.

New Recovery Plants

In 1941, German plants with a sulphuric acid consumption of 24,875 tons, recovered 15,700 tons of iron sulphate, a low rate presumably due to the wartime emphasis on production of essentials rather than by-products. It is estimated that over 100 recovery plants have now been ordered or installed in Germany. Before the war about 6000 tons of recovered iron sulphate were sold for such agricultural purposes as weed control, treating seed grain and killing insect pests. About 1200 tons were used as a flocculant for water purification in place of ammonium sulphate. Some was also used in tanning, dyeing, and wood preserving.

Treatment with Ammonia

The Germans have also treated iron sulphate with ammonia (mainly in aqueous solution) to produce ferric hydroxide and ferric oxide (by chemical precipitation), and ammonium sulphate. The ferric oxide is used as a pigment for paints and as a polishing material in the optical industry. The ammonium sulphate is used as fertiliser. In the author's opinion, German experience with iron sulphate recovery "should definitely prove that iron sulphate recovery from spent pickling liquors has passed the stage at which its usefulness should still be doubted. . . . The process, from every viewpoint, has become an established fact, with a sufficient number of advantages in its favour to render its installation worthwhile."

Enterprise Scotland Visitors.—Visitors to the "Enterprise Scotland" Exhibition numbered 456,193.

IMPROVED GAS PURIFICATION

Process for Sulphur Removal

AN improved gas purification process, more particularly for removal of sulphur from industrial gases, is the subject of English Patent No. 95/1946 of the Koppers Co., Inc., now open to inspection. The use of suitable organic sulphur absorbents are already known but are subject to various disadvantages. The principal object in the present invention is to provide a method of separation by use of amine absorbers of organic sulphur compounds in which the absorbent is only moderately in excess of that required for absorption, associated with an oil scrubbing medium.

Scrubbing Medium

The various absorbing agents suggested are primary or secondary amines, such as morpholine or piperidine and homologues, or hydrogenated tar base fractions. Among the primary are mono-ethanolamine and iso-octylamine which have given good results. The scrubbing medium, which must be a solvent of amines and form sulphur complexes, may be water, aliphatic alcohols, ketones, or hydrocarbon oils. By way of example, the use of morpholine wash oil scrubbing medium is described and illustrated.

The morpholine sulphur complex and other salts are dissolved out of the scrubbing medium by sodium hydroxide solution to form principally the corresponding sodium compound, and available free morpholine is divided between scrubbing medium and caustic solution. Various agents may be used for reviving the scrubbing medium, such as, tricresyl phosphate and glycerol, or, as in co-pending application, it may be revived in a contactor, preferably with water, and then returned into the operating cycle.

Korea's Chemical Industry

BEFORE the surrender of Japan, Korea's chemical industry was highly developed by the Japanese, states Summation No. 20 of U.S. Army Military Government Activities in the country. The subsequent evacuation of the Japanese and the partition of the country at the 38th parallel resulted in the severance of the chief sources of raw materials, including, of course, of coal, of skilled technicians and of replacement parts for machinery and equipment.

Of South Korea's three chemical fertiliser plants, the summation adds, producing calcium superphosphate at Inchon, calcium cyanamide at Pukpyongni and potassium sulphate at Mokpo, only the last is now in operation, and in March last was stated to have ground 2450 metric tons of phosphate rock.

PRINCIPLES OF DIE CASTING

A Study of Contemporary Practice

ONE of the most comprehensive studies of the fundamental principles of die casting, reviewing the metallurgical considerations and selection of alloys for special purposes and presenting many vital data in tabulated form is the booklet just issued by the Federated Metals Division of the American Smelting and Refining Co.

The most rapid progress in the die casting field has been made during the past 25 years. The development of high purity (99.99 per cent) zinc, which is of recent origin, was instrumental in rapidly expanding the industry. Next to the tin-lead alloys, those made of zinc offer the least difficulty in manufacturing.

Castings of the original zinc alloys, however, showed deterioration and instability, due to the fact that the effects of minor impurities within these alloys were unknown. The introduction of high purity alloys alleviated most of these problems and to-day die castings made of zinc base alloys are used in the same way as other engineering materials and covered by specifications and standards.

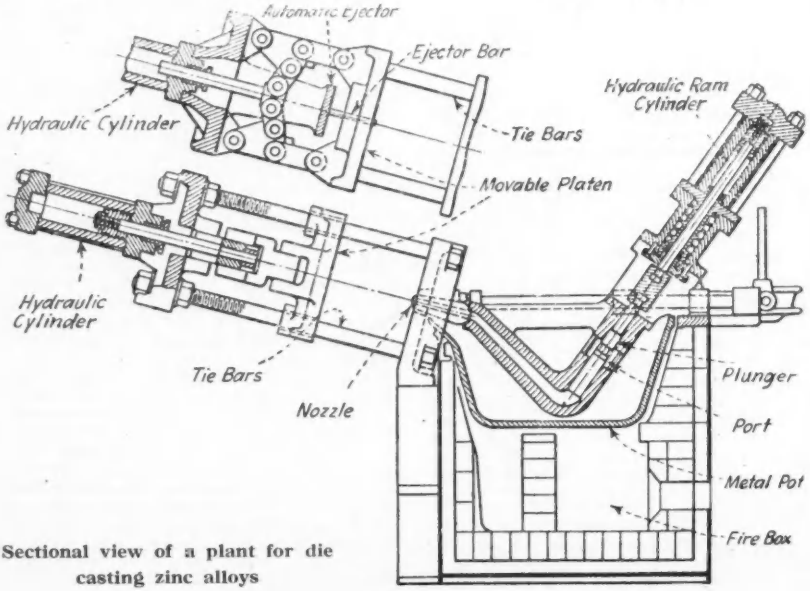
Alloys that are commonly die cast are those of zinc, aluminium, magnesium, copper, tin, and lead in approximately the order named. Alloys of the latter two are used only to a limited extent; the zinc base alloys account for more than two-thirds of the die castings made in various countries to-day.

This is due in part to the low melting point of these alloys and the ease with which they can be handled in the die casting shop. In view of their low pouring temperature, die cost and maintenance are lower than any of the higher melting alloys. The castings can be held to very close dimensional tolerances and they are easily machined and finished. Their excellent mechanical properties are exceeded only by those of the copper base alloys. Great advantage lies in the fact that castings made from zinc base alloys are, in general, cheaper than those made of competitive alloys.

High Pressures

The use of many alloys in the die casting industry has brought about the development of machines tailored to accord with the characteristics of the metals to be cast. In general the two types of machines use either a hot chamber or a cold chamber. The cold chamber machines use pressures ranging from 5000 to 50,000 lb. per sq. in. and are referred to as high-pressure cold chamber machines.

(*Continued on page 604*)



Sectional view of a plant for die casting zinc alloys

TIN AN ANTI-CORROSIVE

A RECENT issue of *Tin and Its Uses*, published by the Tin Research Institute, contains an interesting and informative account of research work undertaken by the Institute in connection with the use of tin coating as an anti-corrosive material.

Over a four-year period a series of tests has been carried out with various steels. A number of identical steel panels were undercoated with all the well-known corrosion-resistant materials, or were subjected to one or another of the various rust-prevention treatments before being painted in the normal way. At the same time a few panels were given a thin coating of tin (0.00005 in. thick) before the paint was applied. Periodical examination revealed that not only did the pre-tinned specimens retain their paint longest, but the tinned surface where exposed was free from rust and could be repainted without the need for cleaning and scraping. The untinned steels, however, had rusted beneath the paint.

Quite apart from the protective value of tin as an undercoat for painted steel—its recommended thickness is 0.00003-0.00005 inches—there is also the added advantage that the estimated cost of applying an undercoating of tin to both surfaces of a sheet of steel amount to less than a quarter of that for labour and materials required to apply a coat of paint to one side of the sheet.

ZINC AND TITANIUM

Wider Use in Paints Approved

FOR a good many years—records the bulletin of the Zinc Development Association—official pronouncements on outside paints have concentrated mainly on white lead among the available white pigments. The recent revision of B.S.929 on "Ready Mixed Paints," which has just been published, alters all this. It no longer prohibits the mixing of white lead with other pigments. For outside work it allows mixtures of two or more of the titanium dioxide, zinc oxide and white lead paints; for inside work mixtures of two or more of the above three pigments and lithopone. This recognition of the value of mixed pigments is in line with modern manufacturing experience, and represents a forward step in the art of paint making, which the Zinc Pigment Development Association welcomes.

A foreword to the specification urges that full advantage should be taken of this provision, so that the use of available raw materials now in short supply shall be spread over a greater quantity of paint.

The restrictions on the use of lithopone, the bulletin suggests, are hard to justify in view of its entirely successful use in the past.

OFFICIAL NOTICES

Zinc Sheets and Rolled Zinc

The Ministry of Supply announces that the prices of zinc sheets and rolled zinc (boiler plates) has been increased by 17s. 6d a ton as from October 16, making the maximum selling price of zinc sheets £82 a ton, and of boiler plates, £80 a ton. The increase is to cover increased manufacturing costs. In addition, the existing premia on thin gauges and odd sizes, not covered by the Statutory Order, will be increased by 50 per cent.

Platinum and Tungsten Ore

Increased metal prices announced in London last week were: tungsten ore, from 122s. 6d.—127s. 6d. to 125s.—132s. 6d. per unit, c.i.f.; platinum, from £15—£15 10s. to £15—£16 10s. per troy oz.

Fluorspar Import Licences

The Board of Trade announces that from October 28, 1947, fluorspar can be imported only on individual licence. Imports have hitherto been unrestricted.

Lactic Casein Prices

The Board of Trade announces that from November 1, 1947, the selling prices of lactic casein, distributed through the agency of the Lactic Casein Importers' Association, Ltd., 23 St. Swithin's Lane, London, E.C.4, will be as follows (per ton):

Mesh	1 *ton and over*	*Under* 1 ton
90	£195	£200
60	£190	£195
30	£190	£195
Soluble	£200	£205

For quantities of under one bag the price is 4s. 6d. per kilo. All the prices are net *ex* warehouse.

Training for Metallurgists

A period of practical training for young metallurgists entering the steel industry, in addition to their university and technical college studies, was strongly urged by Mr. T. M. Service, a director of William Beardmore & Co., Ltd., Parkhead, Glasgow, in his presidential address to the West of Scotland Iron and Steel Institute in Glasgow on October 17. Metallurgists had recently entered the steel trade with the job of suggesting improvements in manufacturing methods based on the knowledge they had acquired at the university or technical college. Mr. Service said that scientific knowledge alone was not enough, and that it was necessary for young metallurgists to have a minimum of two years' practical works training. If workers knew that those in charge were capable of doing the job themselves they would willingly support any innovations.

Hydrogen Peroxide Process

Production by Electrolysis

THE production by electrolysis of 35 per cent solutions of peroxide of hydrogen is described in a further BIOS report. (BIOS Final Report, No. 683, Item 22; 2s. 8d., post free.)

The process forming the subject matter consists in the feeding of a solution of 500 g.p.l. H_2SO_4 to the catholytic chamber of the first bath; this solution passes through each subsequent bath until it has reached the bottom of the cascade. It is then returned as anolyte feed to the battery through a distribution box and is next passed through one of ten diaphragm series where electrolysis takes placle so as to yield a solution containing 250 g.p.l. of H_2SO_8.

The latter is fed through a steam-heated lead coil where evaporation to roundly half its volume is carried out and hydrolysed to give H_2O_2 vapour and a solution consisting of some H_2O_2 and H_2SO_5 (Caro's acid). The hydrogen peroxide vapour is passed to a fractionating column from which a 35 per cent w/w solution of H_2O_2 is separated, and the vapours passing from the top of the column are passed to a second fractionating column, where a weak solution of 0.5 per cent H_2O_2 is separated.

Acid Removal

To remove as much as possible of the H_2O_2 H_2SO_5 remaining, the acid residue from the lead coil is steam distilled and the vapours passed into the main vapour pipe leading to the first column. The residual acid from this operation is diluted and returned to the electrolysis phase with the exception of 5 per cent, which is purified before returning to the cycle (by distillation).

This process, which was originally worked out by the Osterreichische Chemische Werke, Weissenstein, Austria, was later licensed to the Degussa, where it was used in the main for the manufacture of sodium percarbonate or sodium perborate. Is is worth mentioning that "a fair sized" workshop was attached to the plant, where pipes, valves, etc., were fabricated from products of the polyvinyl type. It was apparent that considerable developments were taking place in the application of plastics for chemical plant.

New Chemical Journal.—Elsevier Publishing Co., Inc., of New York and Amsterdam, has published a new international chemical periodical entitled *Analytica Chimica Acta*. It is an international journal devoted to all branches of analytical chemistry, and is published monthly. The editor is Paul E. Wenger, and the subscription fee 9.50 dollars a year.

Adulteration of Ceylon Papain

Steps are being taken by the Department of Commerce and Industries, Ceylon, to prevent the export of adulterated papain, which often has up to 50 per cent powdered gum arabic, manioc powder or powdered pawpaw fruit. There has lately been a decrease in the export of papain and a probe by the department has revealed that the United States, the chief buyer, is disinclined to purchase Ceylon papain.

Pure Ceylon papain has a ready market in the United States, where buyers paid nearly Rs. 12.50 a lb. earlier this year. With a view to safeguarding the trade and to protect the interests of *bona fide* dealers as well, the Commerce Department has laid down certain conditions for the export of papain.

Polish non-ferrous metal production for September amounted to:

Sulphuric acid 100% ...	8388	tons
Zinc, powdered	6427	,,
Zinc, sheets	2979	,,
Zinc ore	72,517	,,
Zinc pyrites	1253	,,
Zinc concentrates ...	11,212	,,
Zinc roasting blendes ...	9915	,,

(*Continued from page* 602)

In the hot chamber machines, a "goose neck" device, so called because of its shape, is continuously submerged in the molten metal. The latter is forced through the "goose neck" into the die by means of direct air pressure or by a plunger. The "goose neck" or hot chamber machines are used almost entirely for the casting of zinc base metals, since alloys of aluminium, magnesium and copper, because of their higher melting points, are too corrosive to this type of equipment. Such machines operate at comparatively low pressures, in the range of 1000 to 2000 lb. per sq. in.

In general it should be noted that the term "die casting" refers only to machines in which pressures higher than gravity are employed. Castings produced in metal moulds without the use of external pressures are commonly referred to as permanent mould casings.

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Metallurgical Section

Published the first Saturday in the month

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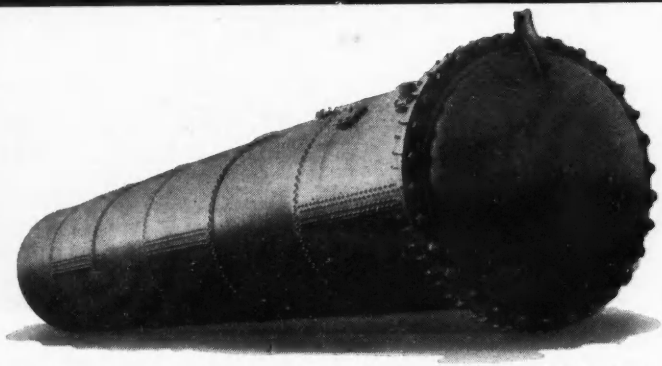

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Metallurgical Section

6 December 1947

Oxygen Enriched Blast

Wide Use in German Industry

THE use of oxygen-enriched blast for metallurgical processes in the U.S.A. has generally related to open hearth methods and has been widely applied there within recent months. In Germany, however, the emphasis has been on blast furnace production, according to a report on the use of oxygen in the German iron and steel industry by Dr. Walter M. Pollitzer, a U.S. Government investigator.

Pig iron as well as ferro-chromium are produced in Germany from low-grade materials with oxygen-enriched blast. Pilot plant experiments have been conducted successfully since 1935 in one large blast furnace, and at two other places in low shaft blast furnaces. One large steel mill in Germany has used oxygen enriched blast for its basic converter for more than ten years.

German experience has resulted in important advances in economical production. Pig iron, for instance, has been successfully produced from normal or low grade ores, ferro alloys from ores otherwise considered sub-standard, and high quality steel in basic converters with heavy additions of cold scrap.

Pioneer Experiments

So far as is known, the Gute Hoffnungs Huette plant at Oberhausen was the first large steel firm in the world to build a blast furnace for experiments with oxygen-enriched air, according to the report. At that time (1933) the Frankl method for producing oxygen cheaply had been developed. Experiments at Oberhausen proved that the oxygen-enriched method of pig iron production was economical and that all technical metallurgical problems could be mastered.

Dr. Pollitzer's report contains a technical description of the Oberhausen experiments and two tables of test results. "The coming era in iron and steel production will have to utilise more and more low grade ores and fuels," Dr. Pollitzer states, "so the industry will be compelled to look to new methods. General economic considerations can lead to the application of more concentrated blast in other metallurgical processes, so the progress made in Germany under war pressure may prove useful stimulus to work in other industries."

[Utilisation of Oxygen in the German Iron and Steel Industry, Number PB-81385, 26 pages, mimeographed; 75 cents from the Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.]

Electronic Comparator

Automatically Distinguishes Metals

AN electronic instrument, the metals comparator, has been introduced by the special products division of the (U.S.) General Electric Company for providing a quick, non-destructive comparison of either magnetic or non-magnetic metal parts with a standard. Parts appearing alike but differing in composition can be separated quickly with the new instrument which has been used to differentiate between annealed and unannealed steel bars, and also to sort finished metal parts with different compositions or heat treatments.

The new metal comparator in use

The comparator employs a balancing network and indicating instrument mounted in a steel cabinet to which is connected an external test coil. In operation, a reference specimen for the group of specimens being compared is first placed in the test coil and adjustment made to secure the initial balance. This is indicated by a zero reading on the indicating instrument. After the reference specimen has been removed, the parts to be tested are inserted briefly in the coil one by one. When tolerances have been established, specimens can be accepted or rejected on the basis of the dial reading. As many as 1500 small parts can be tested in an hour.

WELDING AND FLAME CUTTING

Rapid Repairs Help to Maintain Production

by C. W. BRETT, M.Inst.W.*

CONFLICTING statements make it hard to assess the extent and power of the blows that, we are told, will further handicap industry in the near future. While it would be foolish to be over anxious, it would be prodigal to neglect any means of increasing the quality and quantity of output. The emphasis upon export requirements is still further deferring the replacement of much needed plant in this country and retarding developments of various kinds.

In this respect the chemical industry is in a position no better than other equally important production spheres; in fact, there are some aspects in which it would appear to be worse off. An analysis has been made

A large cast iron cauldron extensively cracked and destined for scrap

in certain quarters of the resources available to facilitate modifications of plant, and also to indicate the best methods with which to tackle maintenance and repair problems. The result of this has been to emphasise the dependability, low cost and speed of modern methods of welding.

Corrosion Problems Solved

The following clearly supports that conclusion. A short time ago a firm of scientific welding specialists was consulted in regard to large pressure containers used for somewhat corrosive materials. This had led to inordinately high maintenance costs. Obviously a lining was required to protect the mild steel of which the holders are composed. After careful consideration strips of corrosion resisting metal were welded to the inside of the container until it was entirely covered. The cost was relatively small but the modification has very greatly increased the life of this item of equipment.

Not long ago work of this kind was sometimes impracticable because of the wide difference in expansion and contraction between one or other of the metals being welded. A method has been devised to overcome this difficulty which, at one time, seemed almost insuperable.

* Managing director, Barimar Ltd.

Much of the success achieved in this connection is due to improved means for restricting heat flow from the localised area in which the actial work of welding is being carried out. In view of the fact that 6000°-7000°F. are essential to successful welding

The same vessel completely rehabilitated by welding, which has repaired the fissures and replaced metal eroded by use

of this kind it might not seem possible to prevent local expansion causing distortion and even cracks. In fact, so efficient is the equipment now used and the technique applied by the operator that if welding ceases momentarily it is possible to touch close to the centre of the work without discomfort. The problem of the dispersion of heat has been overcome.

In the lining of containers subject to corrosion, sprayed metal is sometimes applied, but for heavy duty, where considerable thickness of material is involved, the use of welded strips of stainless steel or other resistant material is favoured. Spraying, too, has many uses of a similar kind. A wire or powder of the metal it is required to spray is passed through an oxy-acetylene flame. The molten particles are ejected by a stream of compressed air and a tenacious coating is built up upon any matt surface. It is this process which has taken the place of some forms of galvanising, while the spraying of stainless steel together with other special alloys may provide a means of prolonging the life of plant and consequently reducing the cost of upkeep.

An aspect of the latter process that should not be overlooked is the porosity of the sprayed metal, although this does not prevent it from taking a high polish. It is a

factor, however, which is often an advantage, as for example its ability to retain lubricating oil in the pores of the metal

Multi-Layer Work

A point that arises, sometimes in the form of unfounded criticism, is the influence of the weld upon heat-treated steel. This influence is always compensated. If the characteristics of the weld are likely to be influenced locally then restoration is merely a matter for further treatment.

A fact apt to be overlooked is the automatic correction that takes place with certain classes of repair. In the case of multi-layer welding applied electrically a run of weld metal has a valuable normalising effect upon the run which immediately preceded it. Moreover, work of this class has a much finer grain and is far more reliable than a heavy single-layer weld which is apt to have a coarser crystalline structure.

As the final run of welding is not normalised in the manner of the previous run an adequate amount of surplus metal is left on the component so that when it is finally machined the weld consists of normalised metal throughout.

So effective are the results that the method is applied to crankshafts of all kinds. One of these handled recently weighed more than 30 cwt. and not long ago the crankshaft of a railway locomotive was re-united with equal success. Truth of alignment is guaranteed to within .001 in.—no small feat, seeing that distortion usually follows a smash of this kind.

Metals that are totally unlike one another in their characteristics, such as aluminium and steel for example, can be welded together perfectly. This is done with such strength that if a test to destruction is made it can be proved that the area of union is definitely stronger than the weaker of the two parent metals. This development opens up an entirely new field of opportunity, not only in relation to repair work but in new construction.

Scientific welding lends itself to the production of special machines of which, possibly, one only may be needed. By fabricating steel plate lightness is obtained combined with great strength. In addition the work is far cheaper than if castings were used, for patterns are rendered unnecessary and unless the cost of these be spread over an adequate output of castings the outlay is a very serious expense item.

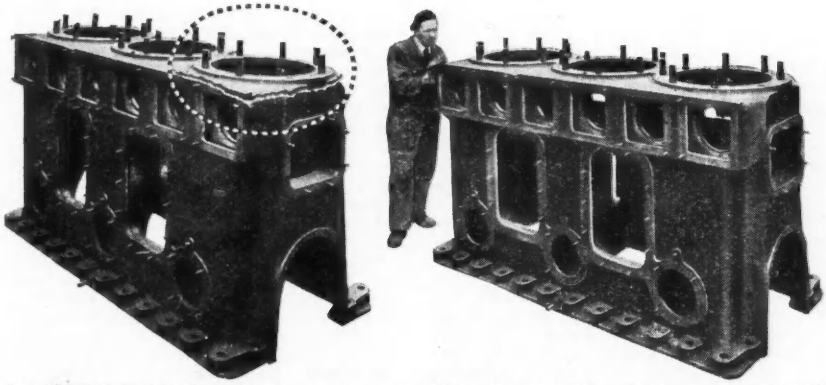
Most repair work on plant or parts weighing less than 12 tons is sent to the shops of specialists; where greater weight or possibly unwieldiness renders transport uneconomically possible, self-contained equipment and specially trained operators are now available to deal with emergency work on the site.

An important adjunct of modern welding is a well-equipped machine shop to which certain types of components must be passed for precision machining. In this way responsibility is not divided, perfect fitting is assured and the work can be guaranteed.

Assured Results

Welding repair work in particular calls for a very high degree of craftsmanship on the part of the operator and strict inspection is made at various stages involving the use of radiography. The examination nowadays is so searching that any flaw, no matter how small, can be detected and eliminated at once.

(*Continued on page* 734)



Specialised welding methods were responsible also for this "before and after" contrast, a piece of work which restored to use a vital diesel power unit which could not readily have been replaced.

One indication of the trust currently reposed in welding is its application to boilers of all kinds when they are in need of reconditioning. Riveted patches are avoided entirely since new sections of plate can be butt welded in position, leaving a perfectly clean surface inside and providing a completely adequate margin of strength. This method is approved by insurance companies.

Another line of progress is the increased thickness of metal that can be handled. Some massive castings repaired recently had a section of 10 in. but even such a substantial thickness of metal does not represent the maximum that can be welded. At the other end of the scale extremely delicate precision parts may be restored to a condition equal to new.

A phase of modern progress that deserves close attention is the increasing application of light metals. Output in this direction has grown immeasurably during the past seven or eight years with the result that production costs have dropped. Even magnesium alloys which may be highly inflammable in the form of swarf or filings can be welded perfectly and without risk. In common with all repair work, however, experience and skill of a high order are among the essential ingredients in this kind of work.

More and more industry is looking toward scientific welding both to help out in time of emergency as well as to aid in many branches of productive work.

Flame Cutting

An ancillary process, flame cutting of components, has now reached such a degree of accuracy that it is common practice to form gear wheels and sprockets in this way. Many machines now in operation have flame cut pinions, not one of which requires machining after being shaped from the solid. This, of course, is not done by hand; for the flame follows the contour of a master pattern with extraordinarily accurate results.

There is a striking contrast between the various types of work tackled and equal variety in the metal needing attention, but whatever the latter may be it can be matched with a suitable welding rod. The weld is invisible and, when it is required, a considerable increase in strength can be imparted to enable a component to deal with overload safely or meet conditions more severe than those for which it was originally designed.

Sometimes gear wheels are broken; it is immaterial whether they are of steel, cast iron or non-ferrous metal, for even when teeth are smashed and lost they can be built up afresh and re-cut with absolute precision. An important consideration just now is the short time in which even complex repairs

(*Continued in next column*)

Widespread Tungsten Shortage

Japanese and U.S. Supplies Inadequate

A SURVEY report on tungsten resources of Japan, prepared by H. R. Klepper, scientific consultant with the U.S. Army in Japan, containing a brief analysis of the production and exploitation methods used in eight major tungsten deposits has been placed on sale this week by the Office of Technical Services, U.S. Department of Commerce. The report points out that all Japan's tungsten mines and plants for processing tungsten concentrates stopped production in August, 1945, although small-scale operations were resumed at eight mines in 1946. These mines produced 42 tons of concentrates in the first six months of 1946, and the concentrates are estimated to contain between 50 and 60 per cent tungsten trioxide.

If Japan can purchase foreign (Korean) tungsten concentrate to fill her industrial requirements, it is almost certain that only two or three of her tungsten deposits would be exploited economically and that the domestic output in any year would probably not exceed 150 tons of concentrate containing 60 per cent tungsten trioxide.

In the United States, tungsten ore deposits that were exploited during the first world war in Boulder County, Colorado, and Atolia, California, have been nearly exhausted, according to a recently completed survey of America's resources. Although more tungsten may be found, the United States will probably be forced to rely heavily on imports.

(*Continued from previous column*)

are carried out. Usually a job can be completed within 24 hours even when a certain amount of final machining is required.

This facility for quick replacement goes far towards answering the current shortage of replacement parts. A proportion of new replacements are no doubt indispensable, but in a majority of cases an all-round saving would result from modern methods of repair, a saving not only in time and money to the owners but a national economy in freeing capacity to turn out more material for export.

The delicate adjustment that seems essential to modern production methods is easily upset by the failure of one of a plant's key components. Because it permits such an item to be restored more rapidly than a replacement could have been obtained at the best of times, the welding industry is to-day playing a part in maintaining output the importance of which can hardly be overestimated.

STAINLESS STEELS FOR THE ENGINEER

FROM the metallurgical point of view, stainless steels useful to the chemical engineer are: (1) non-hardening chromium-iron alloys, (2) chromium-iron-carbon alloys, with or without nickel, hardenable by quenching, and (3) anstenitic iron-chromium nickel alloys, non-hardening or hardened by precipitation.

In addition, the steels have been tabulated by B.S.S. and A.I.S.I. specification number, listing mechanical properties and giving notes on applications.

A further useful table (given here) represents weight losses in various acids.

WEIGHT LOSS OF STAINLESS STEELS IN GMS./IN².24 HRS.

Reagent	Temperature	18Cr./8 Ni.	18Cr./18Ni./Mo./Cu.
69.8% HNO_3	20°C.	0.0000	0.0000
	b.p.	0.0006	0.0011
20% HCl	20°C.	0.0512	0.0008
80% H_3PO_4	b.p.	0.7896	0.0084
10% H_3PO_4	b.p.	0.0000	0.0000

The table is only a rough guide since it was drawn up from experiments with pure materials, and industrial liquors with their impurities may give pitting corrosion, despite the apparently favourable results shown here.

There is a gain in resistance to attack as one passes along the range of compositions, 13 per cent Cr, 17 per cent Cr/2 per cent Ni (S80), 18 per cent Cr/8 per cent Ni. Further additions of Mo and of Cu increase corrosion resistance.

Because of its generally greater corrosion resistance and its more ready production and fabrication, the 18 per cent Cr/8 per cent Ni type, with or without additional elements, is the most important stainless steel in chemical engineering.

In addition to molybdenum; copper, titanium, columbium and silicon in various combinations are important additions from the point of view of resistance to intercrystalline corrision, especially after welding.

Welding

The 18/8 materials can be welded by practically all the normal techniques. Early attempts resulted in "weld decay" when the weld was exposed to corrosive conditions. This is due to chromium carbide precipitation at grain boundaries when the steel was heated to 600°-700°C. Since the corrosion resistance depends on the chromium, the region adjacent to the weld, which is denuded of chromium, becomes liable to attack. Titanium and columbium form carbides in preference to chromium under these conditions. Consequently, the addition of these elements improves the welding properties of these steels. In Britain titanium is more usual, in U.S.A., columbium. A large proportion of the stainless steels used in chemical engineering are of this type.

Machinability

The anstenitic stainless steels are tough, requiring best quality tools and special conditions of steel and feed for machining. In order to improve machinability, incorporation of small quantities of lead, copper, sulphur, selenium, zirconium and molybdenum have all been attempted. In one instance, a drill seized after four holes in a 18 per cent Cr/8 per cent Ni/1 per cent Ti alloy, but in a corresponding free-machining quality more than 280 holes were achieved.

Corrosion resistance is not influenced by these additions and, in some cases, no changes in micro-structure are evident. Sulphur, however, does affect the structure.

Many of the heat-resisting stainless steels are still very tough and very difficult to machine, although doubtless they will also be made more machinable.

Conclusions

Stainless-clad plate is another variant of importance to the chemical engineering industry. A sandwich with mild steel as filling is produced by rolling together the clean surfaces. Difficulties, however, arise in welding and in the stresses within the material due to unequal coefficients of expansion of its component parts.

The material most widely used remains mild steel with relatively low tensile strength, good machinability and low cost. In general engineering, only highly stressed parts or conditions of high temperature call for alloy steels.

Of the stainless steels, the 18 per cent Cr/8 per cent Ni type is of widest application. Compared with mild steel it is a difficult and expensive material to manipulate, but not when compared with other materials of comparable performance.

From "The Selection of Stainless Steels for the Chemical Engineering Industries," paper presented to the Society of Chemical Industry by Mr. L. Rotherham.

Light Metals Statistics

Ministry of Supply statistics, relating to U.K. production, consumption, imports and uses of light metals in September, have been issued as follows (in long tons):

Virgin aluminium: Production 2212, imports 16,176. *Secondary aluminium*: Production, 8515. *Uses (aluminium scrap arisings)*: 10,576, consumption 8014. *Aluminium fabrication*: 19,872. Magnesium *fabrication*: 234.

Resistant Powder Alloys

Stainless Steel Developments

THE American Electro Metal Corporation has recently introduced a new method of production of a material and products having the physical and chemical properties of stainless steel, in a more economical and satisfactory manner than hitherto. Powder metallurgy technique is employed, and two types of product are obtained: (a) soft, semi-hard, and hardenable kinds with 12-14 per cent chromium and 0.1-0.5 per cent carbon; (b) austenitic, less or not hardenable kinds, with 7-12 per cent nickel, 18-29 per cent chromium, and 0.04-0.4 per cent carbon. These form the subject of English Patent Application No. 11363/1947 under Convention date May 1, 1946. Manganese or other additions may be present up to 1 per cent.

Stainless steel powder produced in any known manner is compacted under pressures of 20-75 tons/sq. in. into a coherent porous matrix in bar, ingot, or the finished shape required, which is then infiltrated with copper, silver, tin or their alloys, so that the pores are completely filled, and the matrix on cooling is firmly bonded with infiltrating particles, and in particular is superficially alloyed. If desired the matrix can be pre-sintered before infiltration.

By compacting the matrix under such pressure the wear on moulding dies is considerably reduced and a suitable porosity of 15-25 per cent is obtained. Porosity can, of course, be reduced by higher pressures or by pre-sintering.

The steel powders used should have varied particle size, *e.g.*, about half should be −100 mesh and the other half + 325; but other variations may be used. The copper powder is preferably of the shotted or comminuted type, as the electrolytic kind is unsuitable owing to gas formation.

Good Corrosion Resistance

An alloy powder of 65-95 per cent copper, 3-5 per cent iron, and/or 3-10 per cent nickel, and/or 3-10 per cent manganese, with or without other constituents was found particularly effective. Various examples are given and tests recorded in regard to tensile strength, hardness, etc. Corrosion resistance is said to be very good.

Test bars were usually heat treated in cracked ammonia at 650° C. for an hour, were precipitation hardenable, and showed a tensile strength of about 90,000 p.s.i. at elongation of 20 per cent. If the heat treatment was for four hours at 375° C. tensile strength was 88,000 p.s.i. and Rockwell B. hardness practically the same, at 86.5. Tin alloy is preferred in some cases for infiltration, when the product is required for low temperature applications, such as in food containers.

Coal and Steel

Africa's Industrial Prospects

A FORECAST that South African coal will be exported at a rate of millions of tons, and high-quality steel prices will be considerably reduced, was made by Sir Miles Thomas when he addressed the Royal African Society last week on the prospects for industrial developments in Africa.

As a means of improving the dollar relationship, he instanced the export of coal from the Wankie mines of South Rhodesia to Argentina. Seams at these mines are 26 ft. thick, said Sir Miles, and lie only 200 ft. below the surface. By the use of native labour, which is available at 5s. a shift, and the application of modern techniques of production and transport, the cost of coal at the pit head is only 10s. a ton. He added that at an annual production rate of 2¼ million tons, the deposits will last for 2000 years.

By utilising the hydro-electric potentialities of the Zambesi and Kariba and applying the cheaply generated current, which would cost less than half a farthing a unit, to refining mineral ores in the districts there, steel ingots could be produced at prices 25 per cent lower than those ruling to-day.

AMMONIUM NITRATE

Dutch Produce Safety Additive

AN interesting development in the production of ammonium nitrate fertiliser comes from the Netherlands State Mines, which is adding dicalcium phosphate as a filler. The chemical is said to contain 40 per cent of useful plant food (20 per cent nitrogen, and 20 per cent citrate-soluble phosphorus pentoxide). The phosphate and ammonium nitrate are not mixed as such, the nitric acid necessary for the production of the ammonium nitrate being first used to dissolve phosphate rock. By neutralising this solution with gaseous ammonia, ammonium nitrate and dicalcium phosphate are formed simultaneously. It is understood that no special raw materials are required for the conversion of the phosphate rock into a valuable fertiliser.

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